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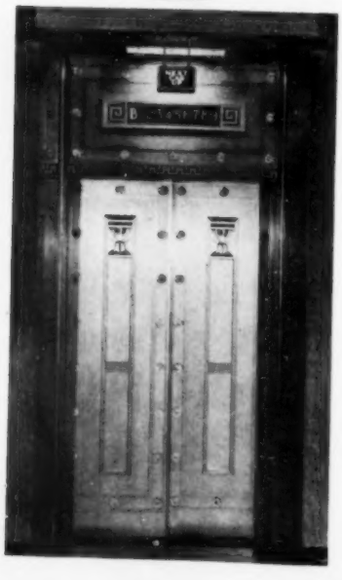

METAL INDUSTRY
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Solution Control With Hydrometers

There was a time not so long ago when control of plating solutions rested largely on the physical appearance of the solutions, anodes and deposits with readings of the density using a hydrometer. The fallacies attendant with the attempt to control salts in plating solutions by hydrometer readings appear even today not to be understood.

The hydrometer or specific gravity reading of a water solution is dependent on the total solids or liquid substances dissolved in the solution. Therefore, hydrometer readings are only strictly accurate for determining the concentration when only one substance is dissolved.

Thus, in a nickel solution, the boric acid, chlorides and other dissolved substances contribute to the increase in specific gravity caused largely by the nickel salts. A large error can result from attempting to determine the metal concentration by specific gravity, if the chloride, boric acid, etc., are high and the metal low.

Likewise, the determination of metal concentration from hydrometer readings of cyanide solutions is fraught with error especially if carbonates and high free cyanide are present.

Alkaline cleaners can be satisfactorily controlled by specific gravity measurements because the readings can be calibrated by measuring known concentrations. Calculations of original cleaner concentrations from titration data may be in slight error, due to variations in the rate of consumption of the various components of the cleaner.

Pickling solutions can be satisfactorily controlled by density when new, but the control may become inaccurate when metal salts have accumulated.

The concentration of chromic acid in chromium plating solutions can be satisfactorily controlled by specific gravity measurements because of the small amounts of sulfuric acid, iron and tri-valent chromium usually present. However, if any of these materials becomes inordinately high, then chemical analysis for chromic acid may be necessary.

The concentration of two substances in a solution together can be determined by analyzing for one component and taking a density reading. Using density tables for various concentrations of the two components, the concentration of the unknown component can be determined by difference. Such a method is used for analyzing acid copper sulfate solutions.

The density of a solution varies considerably with temperature and caution should be taken that the density readings be made at the proper temperature, inasmuch as a density reading taken without regard to temperature may be worthless.

Manganese: A Strategic Metal

The United States lacks ore bodies containing manganese in rich enough concentrations to enable the obtaining of the ferro-manganese alloys necessary in steel making, and as a result almost all of the ores used in making the high manganese-containing ferro-manganese alloys, are imported, and, therefore, manganese is a leading strategic metal for which we are dependent upon foreign sources.

There are huge ore bodies in the United States containing relatively low concentrations of manganese unsuitable for smelting with the usual operations. However, considerable work has been done by the Electrometallurgical Section of the Bureau of Mines, on the electrolytic deposition of manganese from solutions obtained by treating domestic ores. Electrolytic processes have been developed for treating manganese ores of a grade as low as 10 per cent manganese, and estimated cost figures indicate that electrolytic manganese can be made cheaply enough to compete with ferro-manganese, if this is done on a large enough scale. A small commercial plant for the production of electrolytic manganese has been put into operation at Knoxville, Tenn., and considerable interest has been aroused by the possibility of utilizing the large deposits of low grade manganese ores in the Western States by taking advantage of the electrolytic process and the cheap power from the large Western dams.

Finishing Band Instruments

By Frank K. Savage

Research Chemical Engineer,
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Frank K. Savage

The operations in finishing trumpets are described in detail. Different steps for lacquer and plating finishes are outlined.

The procedures used in finishing band instruments are necessarily long and involved. Due to the nature of the product, great care must be used to guard against dents, scratches and nicks not only from the standpoint of appearance but to maintain the extreme accuracy of many of the vital parts. There are usually several and sometimes as many as fifteen or twenty models of each kind of horn fabricated in the Conn factory. Figure No. 1 shows a fairly representative display of cup mouthpiece valve instruments and Figure No. 2 shows a display which is predominately of double and single reed instruments. The finishing departments are called upon to apply several standard finishes and at times special finishes of nearly every description. The standard finishes include satin gold, gold burnish, satin silver with trimmings burnished and bell gold burnished, silver buffed, silver butler finish, bright cobalt nickel, chromium, clear lacquer, and gold lacquer.

The methods of finishing of many of the instruments are very similar and a complete resume of all finishing operations on all instruments would be lengthy and full of repetitions. Since lacquer and silver plate are the two most popular finishes while the trumpet is not only a popular band instrument but receives finishing operations that we believe to be typical of good metal finishing practice, this article will describe these in detail. The following procedures purposely omit altogether or only briefly mention fabrication operations, as it is desired to direct attention in this article more specifically to finishing methods. Figures No. 3 and No. 4 do show two views of the foundry and something of key casting practice since it is desired to refer to these later.

It is desirable in horn finishing, as in many other

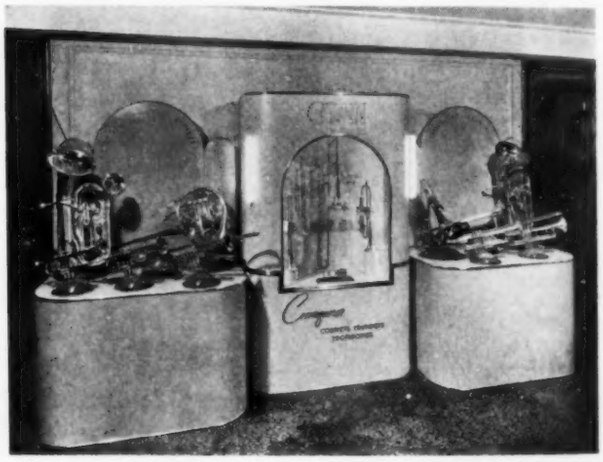

Figure 1. Cup mouthpiece instruments.

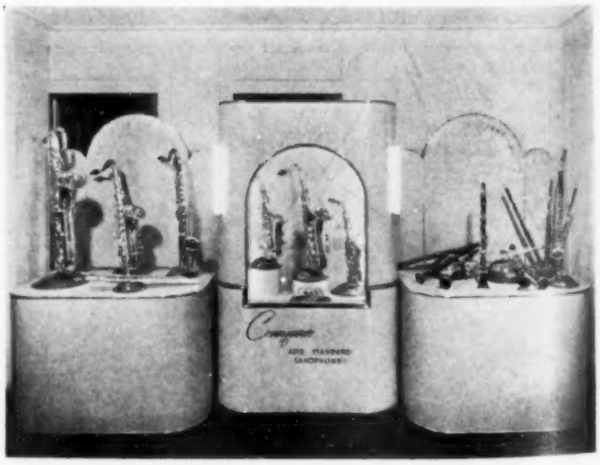

Figure 2. Reed instruments.

Figure 3. Pouring keys in the foundry.

industries, to perform all possible finishing operations before assembling due to the inaccessibility of many areas after assembly. The bell and stem is assembled, hammered, and spun to shape, and the bell rim is formed by rolling in and soldering a steel wire. Before bending the stem, the bell is successively strap-polished the entire length with 180 grain and 240 grain emery. This operation is performed by inserting into the bell a wooden mandrel that roughly fits the inside. A wooden handle allows the bell to turn freely upon its own axis when held against the strap as shown in Figure No. 5. The operator is able to roughly adjust the speed of rotation of the bell by breaking the small end with a pad. The strap speed is about 90 linear feet per second.

Figure 4. Gate of cast keys.

Figure 5. Strap polishing.

Figure 6. Wheel polishing.

Figure 7. Key polishing.

Figure 8. Lacquering a saxophone.

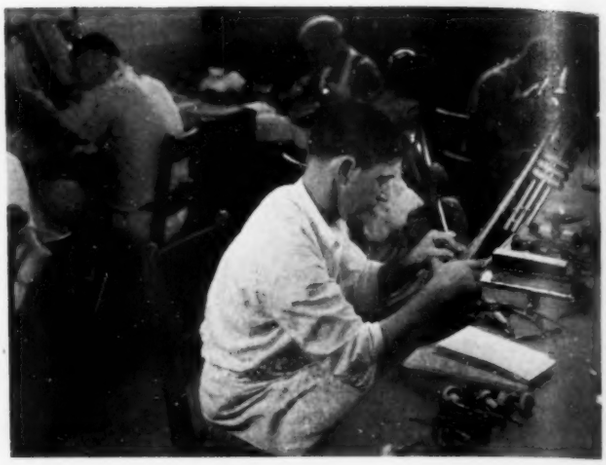

Figure 9. Hand engraving.

After the strap-polishing operation, the outside of the bell flares around the bead, inaccessible with the strap, is wheel polished using a 4″ diameter felt wheel and 240 grain emery at a speed of 3,200 R.P.M. The inside of the bell from the rim down into the throat is successively polished with 180 grain and 240 grain emery with small felt bobber at 3,200 R.P.M. The bell is then filled and bent around a block, repolished where needed to remove strain marks and buffed with 10″ full stitched or partially stitched cloth triplex buffs with tripoli at 3,200 R.P.M. as Figure No. 6 illustrates. Mouthpipes, crooks, knuckles, valve casings and ballisters are successively strap or wheel polished with 180 grain and 240 grain emery depending upon the shape. See Figure No. 7.

Water keys, finger tips, mouthpieces and valve caps are finished smooth enough in the screw machine and punch press departments so that a buffing is all that is necessary. Cloth wheels full or partially stitched of 10″ diameter and 3,200 R.P.M. are used with tripoli.

The above-described operations are the finishing operations which are applied to the various parts before assembly. The parts are produced in large quantities and held in semi-finish stock rooms for future assembly. After the assembling operations, the instruments for plate and lacquer are routed differently.

Lacquer:

1. The excess soft solder around knuckles, braces, rings, and ports is scraped off with a steel tool.

2. The inaccessible parts for wheel finishing are successively emeryed with 180 grain, 240 grain and 320 grain abrasive on rags by hand. Often 240 grain and 320 grain emery or even 320 grain emery alone is sufficient for this operation depending upon the condition of the horn. Pumice ragging is also used at times.

3. A 10″ diameter wheel 2,800 R.P.M. wheel speed with a sewed triplex buff and tripoli is used to buff all accessible parts. The inside of the bell down into the throat is bobber buffed with tripoli at 2,800 R.P.M.

4. Recesses are then ragged with tripoli by hand.

5. After several precision machining operations on the valve assembly, the horns are carefully inspected for dents, scratches and other flaws and repaired if necessary.

Figure 10. *Silver plating.*

Figure 11. *Scratch brushing.*

6. A retouch operation where necessary with tripoli, hand ragging, and wheel buffing is performed, followed by rouge and special composition to prepare the horns for lacquer.

7. After another inspection, the horns are degreased in stabilized trichlorethylene fluid in a special built combination boiling-vapor-spray machine and corked for lacquer.

8. Four coats of air dry clear or gold lacquer is applied by spraying. See Figure No. 8.

9. Figure No. 9 shows the hand engraving operation on the pattern.

10. After cleaning, a final coat of lacquer is applied.

11. The horns are routed to final assembly, to sound proof test rooms and to final inspection.

Silver Plate:

1. The excess soft solder at the joints is scraped off.

2. The inaccessible recesses are ragged with emery 180 grain, 240 grain or 320 grain as necessary.

3. The horns are buffed with tripoli as in preparation for lacquer.

4. After inspection, any dents, nicks or jams are repaired and the horns are retouched where necessary.

5. The patterns are engraved.

6. Most silver plated instruments are satin finished and are sand blasted after corking and shielding the pattern and other areas that are desired bright. The sand blast pressure is necessarily low, (5-7 lbs./sq. in.), to guard against caving in the extremely thin wall material (0.018" and 0.020" in places) and very fine sand is used to give an even and lustrous finish.

7. After the sand blast operation, all areas to be highlighted such as the inside of the bell, the pattern, the tone slide crooks and valve caps are retouched with a buff and a bell bobber buff followed by an inspection.

8. The horns are prepared for silver plate by first removing the valve caps and then either soak cleaning in a hot alkaline cleaner or degreasing in a three phase degreaser using stabilized trichlorethylene.

9. The valve casings are corked tightly top and bottom and the water key hole is also plugged.

10. The work is made anodic in a hot alkali solution for two minutes.

11. A 1-2 second bright dip operation follows without an intermediate rinse. This procedure seems to give a more even and a brighter cleaner surface than if the horn is cooled by rinsing off the alkali. A conventional bright dip formula is used.

Sulfuric acid—H_2SO_4	2 vols.
Nitric acid—HNO_3	1 vol.

With small additions of HCl or a soluble chloride. Charcoal on top of the bright dip is beneficial in obtaining bright, even surfaces. During this operation care is used not to get the bright dip solution inside the bell which would make difficult the subsequent burnishing operation.

12. Following the bright dip, the horns are scrubbed with 1, 2, and 4 row bristle brushes and grade 00 pumice stone.

13. Corks are inserted in the bell and mouthpipe after filling with water.

14. A blue dip for 2-3 seconds coats the brass with an extremely thin film of mercury. The blue dip formula is as follows:

Mercury—Hg	0.09 to 0.11 oz./gal.
Sodium cyanide—NaCN	4-5 "

It has been found that if the dip time is carefully regulated and if the mercury concentration is kept within the above limits by analysis, there is no tendency toward season cracking even on very hard drawn thin gauge cross sections. The author feels that if the proper precautions are taken the extra adhesion obtained on this class of work justifies the use of a mercury dip.

Figure 12. *Hand burnishing.*

Figure 13. *Control laboratory.*

15. After carefully rinsing, the horns are placed in the first silver strike of the following composition:

Silver—Ag	0.4-0.5 oz. Tr./gal.
Sodium cyanide—NaCN	7-8 oz./gal.
Temperature	Room
Voltage	4-6
Time	½-1 minute
Agitation	Hand

16. After rinsing, any area not covered is again scrubbed with 00 pumice.

17. The second silver strike is as follows:

Silver—Ag	0.8-1.2 oz. Tr./gal.
Sodium cyanide—NaCN	6-7 oz./gal.
Temperature	Room
Voltage	1-1.5
Time	10-15 minutes
Agitation	None

The above two strikes are necessary to insure covering soft soldered joints in deep recesses. The local cell action between the solder and brass opposes the current flow at these points sufficiently to inhibit the deposition of silver if conditions are not carefully controlled.

18. After the above pre-plating operations, the instruments are silver plated as follows: See Figure No. 10.

Silver—Ag	3.0-3.2 oz. Tr./gal.
Sodium cyanide—NaCN	4.0-6.0 oz./gal.
Temperature	Room
Voltage	0.8-1.2
Time	1½ to 2 hours
Brightener	CS_2
Agitation	None

19. After uncorking, rinsing, and drying, the bells are buffed with tripoli, cleaned with an alkaline cleaner on a swab and rinsed in cyanide (4 oz./gal.). The throats of the horns are corked and a tight fitting rubber washer is slipped over the bell rim. The bell is then filled with gold solution which is retained around the rim by the washer. A platinum anode is inserted into the gold solution and the bell is gilded.

Gold—Au	4-6 dwt./gal.
Sodium cyanide—NaCN	0.3 to 0.5 oz./gal.
Temperature	40-50° C.
Time	15 minutes
Voltage	5-6 volt

Current density is regulated by size of platinum anode.

20. The scratch brush operation is shown in Figure No. 11. This is done with varying sizes of brass scratch brushes at a wheel speed from 800 to 1,700 R.P.M. A constant trickle of water falls on the work as is clearly shown in the cut.

21. After scratch brushing, the gold bell is lathe burnished by rotating the horns in a jig and burnishing with stellite tools held against a tool rest. The engraved pattern is highlighted by spot burnishing to give contrasting light reflection. See Figure No. 12. Other highlights such as crooks, valve caps, and mouthpieces are either hand or lathe burnished. Steel and stellite tools are used which are conditioned on 0000 emery paper and walrus hide with rouge. A castile soap solution is used as a lubricant.

22. The horns after burnishing are sent to final assembly, sound proof test rooms, and final inspection.

Figure No. 13 shows a section of the control laboratory wherein all solutions are carefully analyzed at regular intervals. Incoming materials such as brass, bronze, copper, and nickel silver are checked for composition, grain size and physical defects. The free sulphur content of all materials used to wrap silver plated instruments is determined and kept within tolerance. Another important function of the laboratory is to make daily analyses on foundry mixtures to keep within the close tolerances allowed as to stiffness, machinability, color and ductility. See Figures No. 3 and No. 4. The laboratory is also constantly at work developing new processing methods which may be adapted to the fabricating and finishing of band instruments.

The Electrodeposition of Nickel from Nickel Chloride Solutions*

By

Dr. W. A. Wesley and J. W. Carey

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Nickel deposited from a nickel chloride-boric acid solution is finer-grained, smoother, harder, stronger and somewhat less ductile than soft deposits from the ordinary sulfate electrolyte. Tested in the as-plated condition, coatings from the two baths are of about equal protective value when of equal thickness. The results of laboratory tests indicate that advantages which can be obtained by electroplating from the chloride solution instead of from the sulfate bath include the following: a 50 per cent reduction in tank voltage and power consumption; ease of control due to simple composition, wide plating range, high anode and cathode efficiencies; lower susceptibility to pitting; smoother, tougher deposits; less tendency to form nodular growths and trees on thick deposits; and production of coatings which are easier to buff. The principal disadvantage of the chloride bath is the greater corrosiveness of the solution. However, modern materials are available which can be used to overcome this.

INTRODUCTION

The use of nickel chloride as the principal ingredient of nickel plating solutions has had an unusual and interesting history. It was early proposed for nickel refining electrolytes on a commercial scale, as in the Hoepfner, the Savelsberg-Wannschoff, and the Browne processes, which established the fact that very thick deposits can be made from a chloride bath. For some reason or other those interested in nickel plating paid no attention to the information developed by the refiners. It is true that numerous baths containing the single chloride salt as the principal ingredient, with ammonium salts, boric acid or other additions, were suggested at different times for electroplating, but they seem to have met with little favor. Langbein[1] sums up the old opinion about them as follows: "There are a large number of general directions for nickel baths, of which nickel chloride, ammonio-nickel chloride, nickel nitrate, etc., form the active constituents, and yet it would be a grave mistake to use these salts for nickeling iron, because the liberated acid, if not immediately and completely fixed by the anodes in dissolving, imparts to the iron objects a great tendency to the formation of rust. Iron objects nickeled in such a bath, to be sure, come out faultless, but in a short time, even if stored in a dry place, portions of the nickel layer will be observed to peel off, and by closely examining them it will be seen that under the deposit a layer of rust has formed which actually tears the nickel off."

Dr. W. A. Wesley

In contrast to the literature on refining, no important studies of high chloride plating baths were recorded until recent years. Blum and Kasper[2] investigated the deposition of thick layers of nickel at unusually high current densities from chloride as well as from sulfate solutions. Their purpose was to develop a method for rapid deposition of a relatively ductile nickel free from strains. Most of their solutions contained no boric acid since this agent was found to have little effect under the conditions used. These workers found that deposits from the chloride baths were invariably more brittle than deposits from sulfate baths of the same pH. All the data they presented were obtained in solutions operated at the boiling point and at current densities above 200 amp./ sq. ft. (22 amp./-dm.^{2}). The deposits from the chloride solutions did possess other characteristics which would be desirable for some purposes. They were of a finer-grained structure, smoother surface and higher tensile strength and hardness. The presence of only 25 per cent of nickel chloride in a sulfate bath made the deposits almost the same as those from pure chloride solutions. It was noted that the cathode current efficiency was always much higher in the chloride than in the sulfate baths.

More nearly conventional plating conditions were employed by V. Waite[3] who studied a series of plating solu-

1. Langbein-Brannt, "Electrodeposition of Metals," 8th Edition, p. 306, (1920).
2. Blum and Kasper, Trans. Faraday Soc., **31**, 1203 (1935).
3. V. Waite, Monthly Rev. Am. Electroplaters' Soc., **24**, 183 (1937).

* Presented at the Seventy-fifth General Meeting of the Electrochemical Society, Inc., and herewith reprinted with the Society's permission.

tions in which from 0 to 100 per cent of the nickel was present as chloride. Although the experimental work was limited to deposition at only one value of pH for each solution tested, the results warranted the conclusion that increasing the chloride content of the electrolyte leads to increase in cathode efficiency, together with an increase in hardness and decrease in grain size of the deposits.

Pinner and Borchert[4], although concerned chiefly with the behavior of anodes, noted that increase in the chloride content of their nickel sulfate plating bath improved the smoothness of the deposit, and increased the cathode efficiency and throwing power of the solution, especially at low pH.

EXPERIMENTAL

Solution Composition

It was decided at the outset of this investigation to select one solution composition and learn as much as possible about the characteristics of both the bath itself and the deposits made from it. The simplest chloride bath would be one containing only nickel chloride. Preliminary experiments, however, indicated that sound deposits could be obtained over a wide plating range only if a buffer were present. The maximum nickel content suitable for commercial operations without excessive drag-out losses was considered to be 75 g./L. Addition of boric acid as a buffer to the nickel chloride solution was all that was found necessary to provide a plating bath capable of producing good deposits under properly correlated conditions of bath temperature, pH and current density.

Chloride Bath. The bath composition selected for intensive study was the following: $NiCl_2.6H_2O$, 300 g./L.; H_3BO_3, 30 g./L. Technical nickel chloride was first dissolved in water and its solution was purified by agitation with an excess of nickel carbonate, followed by saturation with chlorine gas in the presence of the nickel carbonate. The solution was then filtered and diluted so as to contain 75 g./L. nickel. Finally, chemically pure boric acid was added in the required amount. A portion of the original purified solution was kept in a separate container. This was added to the plating bath as required to replace samples withdrawn for pH and quantitative analysis. Determinations of nickel content were made periodically. The nickel content thus recorded was always within the range 75-80 g./L. Operation of the bath invariably resulted in rise of the pH which was corrected before each experiment by addition of chemically pure hydrochloric acid. When it was desired to change the pH to a higher level, this was accomplished by adding nickel hydroxide and filtering.

Later in the work, when it was found that interesting and useful results had been obtained, the principal conclusions were verified with solutions prepared from chemically pure ingredients.

Sulfate Bath. Many of the properties of the chloride bath and of deposits from it were compared directly with those of a Watts-type sulfate bath. The composition of this bath was one which was standard for many years in this laboratory, where a considerable amount of information had been accumulated concerning its characteristics:

$NiSO_4.7H_2O$—336 g./L.
$NiCl_2.6H_2O$—16.5 g./L.
H_3BO_3—30 g./L.

This solution was made from chemically pure salts and was filtered and analyzed for nickel (75 g./L.) and chloride (5 g./L.) content before use.

Agitation. The solution was slowly agitated by introduction of air through a porous alundum thimble which was equipped with a glass chimney so that bubbles could not impinge directly upon the cathode.

Pitting. Pitting was troublesome only in the first day or two of operation of a new chloride bath. The solutions were worked until pitting ceased. No additions to prevent pitting were made to the chloride bath. The aeration mentioned above may have acted as a mild preventative. With the sulfate bath, however, hydrogen peroxide was added once a day in the amount of 0.4 cc. (30 per cent H_2O_2 solution) per liter of plating bath to prevent pitting.

Plating Range of Chloride Bath

The first work undertaken was a qualitative survey of the effects of temperature, cathode current density, and hydrogen ion concentration upon the appearance and nature of the deposits. A twelve-liter glass battery jar was used as the plating tank with two anodes, each 20 cm. wide, 25 cm. long and 0.4 cm. thick. The temperature of the plating solution was maintained constant ± 1° C. by thermostatic control. No anode bags were used. The cathode in each experiment was a piece of 18-gauge deep drawing quality steel 7.6 cm. wide by 15.2 cm. long, suspended vertically from a cathode bar. The bar was moved mechanically in such a way that each point on the cathode surface moved continuously in a vertical circular path of 5 cm. diameter at 30 cycles per minute. The cathodes were prepared for plating by degreasing, alkaline cleaning, pumice scrubbing, dipping in muriatic acid solution and rinsing. The time of plating was selected to yield deposits of an average thickness of 0.001 inch (0.025 mm.). The current density reported was the average current density and in recording the appearance of the deposits it was borne in mind that there had been a

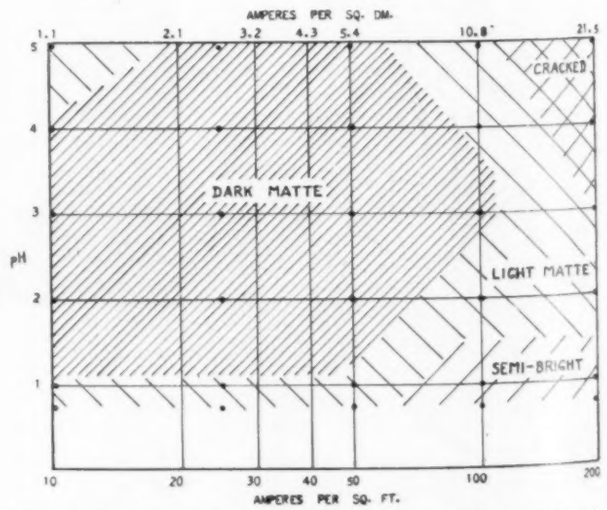

FIG. 1. Plating ranges of chloride bath at 130° F. (54° C.)

4. Pinner and Borchert, Proceedings of the 1938 Convention of the Am. Electroplaters' Soc., p. 84.

higher current density at the edges and a lower at the center of the cathode than the average value.

The survey was conducted at three temperatures, namely, 130, 140, and 150° F. (54, 60, and 66° C.) but the results are given for only two temperatures since the intermediate temperature yielded medial results. Fig. 1 and 2 show that sound deposits were obtained over a very wide range of plating conditions, cracked deposits being encountered only when a high current density and a high pH were employed simultaneously. The positions of the boundaries of the regions shown in these figures are only suggestive, since there is a gradual, not a sharp, change from one type of deposit to another. Each dot shown in the figures represents the conditions maintained in one experiment.

Characteristics of the Deposits

Three types of appearance were presented by the sound deposits within the ranges of the variables investigated. All three were considered good deposits. The descriptive terms "dark," "light," and "semi-bright" refer only to

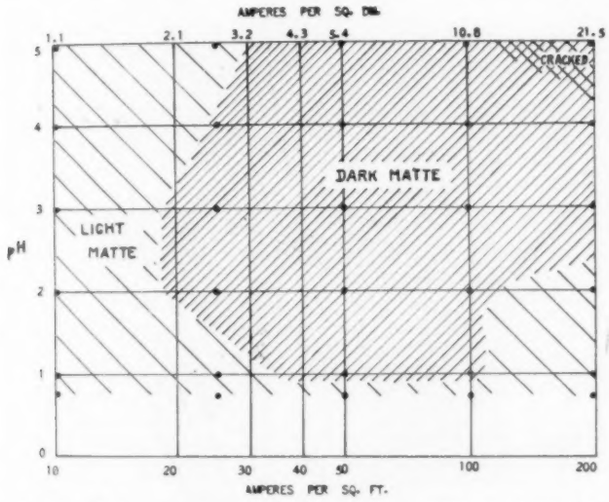

Fig. 2. Plating ranges of chloride bath at 150° F. (66° C.)

the as-plated surface appearance and are not to be construed as colors characteristic of the nickel metal.

The "dark" matte coatings were slate-colored and possessed a velvet-like sheen. They were darker in color than any deposits ever observed by the writers from other plating solutions. That the color was only a surface phenomenon was readily shown by rubbing with an eraser, which brought out the ordinary gray appearance of matte nickel deposits. It was easy to imagine that the dark color was confused by earlier workers with the dark and burnt appearance sometimes encountered in imperfect nickel deposits and that this discouraged them from further study of the chloride bath.

The "light" coatings most nearly resembled typical matte deposits from the Watts sulfate solution. The light plates differed from the sulfate type in that they appeared to be very fine-grained and displayed little or no surface "crystallinity" or texture generally associated with the latter type.

The third type, "semi-bright" deposit, was very smooth and light in color, resembling a mirror with a fogged surface. This type was obtained only in a narrow range of conditions at very low pH and high current density.

The plating conditions selected for production of representative specimens of each type of deposit in the work which follows are those given in Table I unless other conditions are specifically stated.

Table I.

Plating Conditions Selected for Representative Deposits.

	Type of Deposit			
	Dark Matte	Light Matte	Semi-Bright	Soft Sulfate
Solution Composition:				
$NiCl_2.6H_2O$ ..... g./L.	300	300	300	16.5
$NiSO_4.7H_2O$ ..... g./L.				336
Ni ..... g./L.	75	75	75	75
H_3BO_3 ..... g./L.	30	30	30	30
Conditions for Deposits Used for Tensile Tests, Hardness Determinations and Photomicrographs.				
Cathode Current Density:				
Amp./sq. ft.	75	100	100	36
Amp./dm.²	8.1	10.8	10.8	3.9
Temperature:				
°F. ± 2°	150	140	130	130
°C. ± 1°	65.6	60	54.4	54.4
pH (Electrometric) ± 0.2	3.0-4.0	1.2	1.0	2.0
Conditions for Deposits Used for Porosity, Exposure and Erichsen Tests.				
Cathode Current Density:				
Amp./sq. ft.	50	100	100	50
Amp./dm.²	5.4	10.8	10.8	5.4
Temperature:				
°F. ± 2°	140	130	130	130
°C. ± 1°	60	54.4	54.4	54.4
pH (Electrometric) ± 0.1	4.0	2.0	1.0	4.0

Metallographic Examination. Heavy deposits about 0.3 mm. thick were prepared for metallographic examination in cross-section normal to the base. All three types of deposit were found to be very fine-grained in comparison with nickel made from the sulfate bath under the standard conditions. The structures of the dark and the semi-bright deposits are shown in Fig. 3 and 4, respectively, while the light matte deposits were intermediate in structure between the other two. All the deposits from the chloride bath showed very little evidence of a fibrous structure; indeed, it is difficult to distinguish in the photomicrographs that the direction of growth of the metal was vertical, from bottom to top as Fig. 3 and 4 are printed. Contrast this with the columnar, relatively coarse-

Fig. 3. Structure of dark matte deposit. Section parallel to direction of growth of deposit. Magnification, x 500.

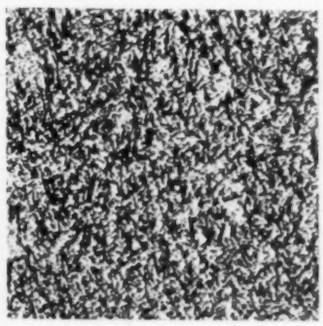

Fig. 4. Structure of semi-bright deposit. Section parallel to direction of growth of deposit. Magnification, x 500.

FIG. 5. Structure of deposit from sulfate bath. Section parallel to direction of growth of deposit. Magnification, x 500.

grained, structure of the soft nickel plated from the sulfate bath, as shown in Fig. 5.

Nodules and Treeing in Heavy Deposits. The ordinary sulfate plating solution shows a rather strong tendency toward production of nodules upon the surface and edges, and "trees" at the corners of the cathode when thick deposits are made. This tendency increases rapidly as the current density is increased and makes difficult the production of smooth heavy deposits at a high rate. Nodules which form upon the surface areas of cathodes are believed to be caused chiefly by the adherence of solid particles, particularly conducting particles, to the cathode. At edges and corners nodules grow without the foreign particle stimulation. The chloride bath was found to be greatly superior to the sulfate bath in producing deposits with smaller nodules and trees. This is at least partly explained by the greater rate of nucleation in the chloride solution evidenced by the fineness of grain of its deposits. It is also probable that conducting particles like nickel or nickel oxide dissolve more rapidly in the chloride bath than in the sulfate, hence it is easier to keep the bath free from them in the former case.

The deposits illustrated in Fig. 6 were prepared from the chloride bath and the regular sulfate bath at pH 4, temperature 140° F. (60° C.) and a current density of 100 amp./sq. ft. (10.8 amp/dm.^{2}) based upon the initial area of the steel cathodes. Slight air agitation was employed but there was no cathode motion. Anode bags were not required or used in the chloride solution. The plating time was 17 hours. The average thickness of the deposit away from the edges was about 0.05 inch (1.27 mm.) in the chloride experiments, whereas that of the deposits from the sulfate bath was appreciably less, due to the fact that metal was wasted at the edges and in the trees. The chloride deposit showed the characteristic dark color which would mislead the plater accustomed to handling ordinary nickel into the belief that the metal was not sound.

The plating conditions selected above were purposely

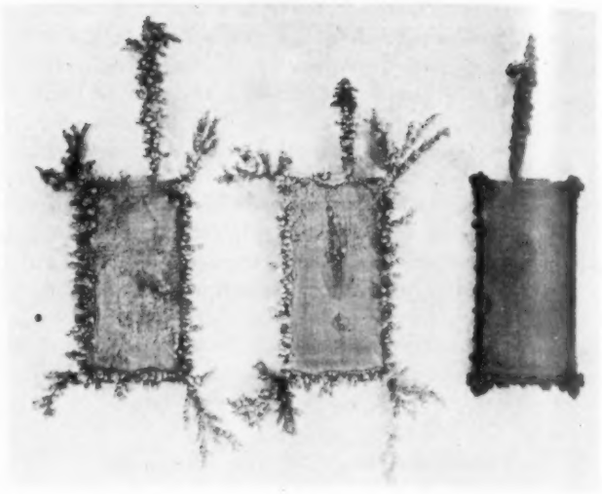

FIG. 6. Thick deposits made under conditions conducive to excessive treeing. Left: From sulfate bath without anode bags. Center: From sulfate bath with anode bags. Right: From chloride bath without anode bags. ¼ natural size.

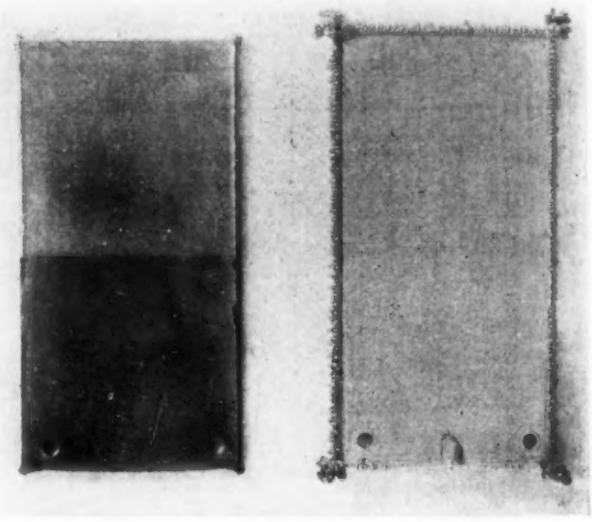

FIG. 7. Deposits 0.02 inch (0.5 mm.) thick. Left: From sulfate bath with bagged anodes. Right: From chloride bath without anode bags. (Note: Lower half of deposit from chloride bath scrubbed with a bristle brush.)

chosen to encourage edge growths. The superiority of the chloride electrolyte was evident, however, even under milder conditions of plating. The deposits pictured in Fig. 7 were made under conditions similar to those of Fig. 6, but at only 50 amp./sq. ft. (5.4 amp./dm.^{2}) and to a thickness of only 0.02 inch (0.5 mm.).

Physical Properties of Deposits

Hardness and Tensile Tests. Deposits of about 0.02 in. (0.5 mm.) thick were prepared for tensile tests. They were plated on an inconel (80 per cent Ni, 13 per cent Cr, 6 per cent Fe alloy) cathode 16 cm. by 18.4 cm. in dimensions, from which they were readily removed and cut into strips 2.5 cm. wide, the long dimension of the strips corresponding to the 16 cm. horizontal dimension of the original cathode. The strips were then machined according to the general form of the standard American Society for Testing Materials' sheet tensile

specimens[5] but were only 6 in. (15.2 cm.) long. The reduced section was 0.500 in. (1.27 cm.) wide and 3 in. (7.6 cm.) long.

The strips cut from the lower part of the deposits were slightly thicker than the others and all individual specimens were slightly thinner at the center than at the edges. For this reason a thickness survey was made of each specimen and it was ruled into 8 arbitrary zones whose exact thickness was recorded. After the tensile test, the zone of fracture was noted and the original recorded thickness at that zone was used in calculating the results of the test. A small tensile testing machine with a 2,000 lb. (907 kg.) range and American Society for Testing Materials' self-aligning grips were used.

TABLE II.

Results of Tensile and Hardness Tests.

Thickness of specimens, 0.4 to 0.6 mm.; plating conditions, see Table I.

Spec. No.	Type of Deposit	Ultimate Tensile Strength lb./sq. in.	Ultimate Tensile Strength kg./cm²	Elongation Per Cent in 2 in. (5 cm.)	Hardness (Vickers)
A2	Light Matte	97,600		12.5	225
A3		102,900		13.0	240
A4		96,300		13.0	225
A5		96,700		16.5	228
Aver.		98,380	6,920	13.8	230
B1	Dark Matte	97,800		22.0	238
B2		99,400		20.0	236
B3		99,500		20.5	240
B5		98,400		19.0	233
Aver.		98,780	6,945	20.4	237
S1	Soft Sulfate	51,800		32.5	150
S2		49,500		28.5	150
Aver.		50,650	3,560	30.5	150

Hardness measurements were made on the inner surfaces of portions of the deposits, that is, the faces originally in contact with the cathode. A Vickers machine was used with the diamond pyramid indenter, and the 10 kg. load.

The results of the tensile and hardness tests are shown in Table II. It is evident that the deposits from the chloride electrolyte are harder, stronger, and correspondingly less ductile than the soft nickel deposited from the sulfate bath. The ductility of the matte deposits from the chloride bath, as indicated by the elongation values, is considerably higher than that reported by Blum and Kasper[6] for deposits made from boiling chloride solutions. Such tough nickel should be an excellent material for building up worn parts, as an undercoat to heavy chromium deposits and for other engineering uses[7].

Erichsen Ductility. Since it was felt that the ductility of relatively thin coatings might not correspond to that of the thick deposits employed in the tensile tests, specimens of sheet steel 0.05 in. (0.127 mm.) thick coated with deposits 0.0010 in. (0.025 mm.) thick were subjected to the Erichsen test. The plating conditions for the different kinds of deposits were those noted in Table I.

During application of the load in the Erichsen test it was quite difficult to decide by simple visual observation at just what stage the coatings cracked, so preliminary tests were run with each type of deposit by checking the visual appearance of the specimens at definite depths of cup against development of cracks as shown by application of ferricyanide gel to the outer surface of the cup.

The results are assembled in Table III and show that the thin dark matte coatings are almost as ductile as soft nickel from the sulfate bath. The light deposits were less ductile, while the semi-bright were moderately brittle.

TABLE III.

Comparative Erichsen Ductility Tests on Nickel-Plated Steel.

Base metal, extra deep drawing steel—18 gauge (0.127 mm.); nickel layer, 0.0010 in. (0.025 mm.) each face; mandrel, 0.875 in. (22.2 mm.) diameter; die, 1.00 in. (25.4 mm.) diameter.

Type of Deposit	Load at Fracture of Coating Pounds	Load at Fracture of Coating Kg.	Cup Depth Inch	Cup Depth Mm.
Dark matte	1,800	816	0.266	6.76
	1,740	789	0.255	6.48
Light matte	920	417	0.174	4.42
	480	218	0.159	4.04
Semi-bright	700	318	0.121	3.07
	760	345	0.128	3.25
Soft sulfate	2,240	1,020	0.29	7.4
	2,280	1,030	0.30	7.6
Unplated steel	3,920	1,780	0.56	14.2
	4,060	1,840	0.56	14.2

Protective Value

Porosity and exposure tests were made with specimens of nickel-plated steel 7.6 cm. by 15.2 cm. in dimensions. The plating conditions for each type of deposit were those given in Table I. For each batch of specimens, preliminary tests were made to determine the exact time required to deposit a coating of a thickness of 0.0010 ± 0.0001 in. (0.025 ± 0.0025 mm.) as determined by metallographic measurement.

TABLE IV.

Porosity Tests.

The number given is the total number of pores counted per one face of a panel of area 1.02 dm.².

Type of Deposit	Dark Matte		Light Matte		Semi-Bright		Soft Sulfate	
Specimen	1	2	1	2	1	2	1	2
Ferricyanide Test:								
Front	14	60	20	10	70	15	60	14
Back	53	38	12	3	13	33	4	10
Aver. of 4	41		11		33		22	
Salt Spray Test:								
Front	3		7		4		4	
Back	2		3		6		7	
Aver. of 2	3		5		5		6	
Atmospheric Test:								
1 Month								
Front	15	11	12	22	18	18	25	18
Back	20	18	11	13	14	9	25	8
Aver. of 4	16		15		15		19	
4 Months								
Front	31	15	18	18	18	14	14	25
Back	50	43	29	32	19	29	47	33
Aver. of 4	35		24		20		30	

5. Am. Soc. Testing Materials Designation, E8-36. Am. Soc. Testing Materials Standards (1936).
6. See footnote 2.
7. W. A. Wesley, Met. Ind. (N. Y.), **38**, 385, 424 (1938).

In spite of the use of guard rings, the thickness within a distance of 6 mm. from the edges was greater than the above, but this zone was not included in expressing the results of the porosity and exposure tests.

Ferricyanide Tests. Ferricyanide gel tests were made with a hot solution containing 10 g./L. agar, 10 g./L. sodium chloride and 1 g./L. potassium ferricyanide. The solution was applied to the specimens when they were in a horizontal position and is was permitted to gel and stand for 5 minutes. The total number of blue spots visible from a distance of about 2 ft. (60 cm.) was counted at the end of this time.

Salt Spray. Salt spray tests were conducted in a mist of 20 per cent sodium chloride solution. The spray box was not equipped with temperature control. The specimens were hung in a vertical position from glass hooks. The results at the end of 100 hours' test are given in Table IV. All rust spots visible at a distance of about 2 ft. (60 cm.) were counted.

Atmospheric Exposure. Two specimens of each type of deposit were exposed in a vertical position on wooden racks in the Bayonne, N. J., atmosphere. Counts of rust spots visible at 2 ft. (60 cm.) distance were made at the end of one and of four months. No other defects had developed.

Porosity. From the summary of all the porosity tests given in Table IV, it is necessary to conclude that the nickel deposits made from the chloride bath are not noticeably different in protective value from deposits made from the sulfate electrolyte. This contradicts the time-honored belief that accelerated breakdown of the coating made from a chloride bath is to be expected, due to a greater corrosiveness of metal chlorides remaining in the pores of the deposit as compared with metal sulfates.

Hothersall and Hammond[8] concluded that the principal causes of porosity in nickel coatings are foreign matter suspended in the plating solution, foreign matter in the surface of the base metal and roughness of the base metal. The fact that deposits made from electrolytes as different as the chloride and the sulfate are nevertheless of approximately equal protective value indicates that porosity is not primarily dependent upon solution composition. This observation is consistent with the physical obstruction theory mentioned above.

Characteristics of the Plating Solution

Tank Voltage. The tank voltage in nickel plating is the algebraic sum of a number of potential differences caused principally by the resistance drop through the electrolyte, polarization of the anode, polarization of the cathode and differences in concentration of the electrolyte. Tank voltage readings may be markedly affected by the shape of the container, the electrode size, shape and spacing, the type of anode bag, the type of anode, and the temperature and degree of agitation of the electrolyte. It is obvious that such readings are of little use unless these factors are described.

A direct comparison of tank voltages in the chloride and the sulfate electrolytes was made by E. J. Roehl. It was done in a rubber-lined steel tank 36 in. (91 cm.) long, 18 in. (45.7 cm.) wide and 36 in. (91 cm.) deep, inside dimensions. It contained 100 gal. (379 L.) of solution. There were 8 rolled depolarized nickel anodes along each side of the tank which were each 27 in. (69 cm.) long with 22.5 in. (57 cm.) actually immersed below the solution level. They were uniformly spaced apart to cover a distance of 25 in. (64 cm.) measured from the outer edge of the first anode to the outer edge of the eighth. The anodes had been about one-half consumed, so that the average width of the immersed portions was about 1.75 in. (4.4 cm.). The total anode area was estimated to be 1,260 sq. in. (81 dm.^{2}). No anode bags were employed.

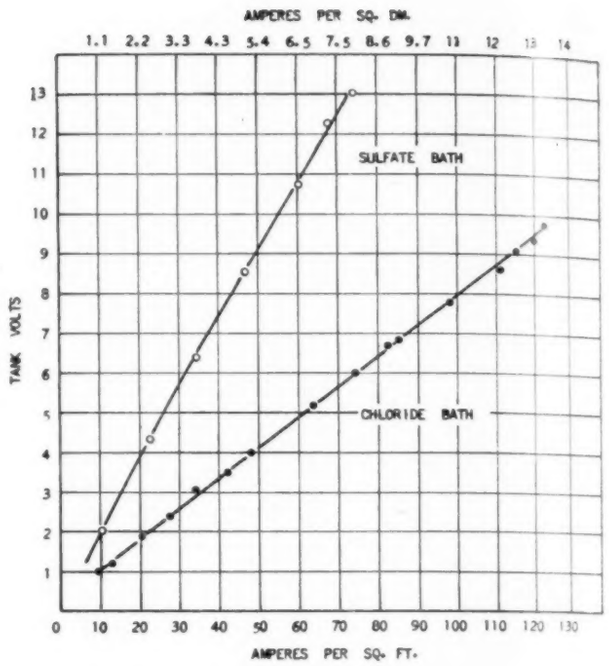

FIG. 8. Tank voltages at pH 4.0 and temperature 130° F. (54° C.)

The cathode was a nickel-plated steel sheet 28 in. (71 cm.) long by 22 in. (56 cm.) wide. The immersed area was 1.232 sq. in. (79 dm.^{2}). The anode-to-cathode area ratio was therefore 1.0. The anode-to-cathode spacing was 6.5 in. (16.5 cm.) measured from center to center of the anode and cathode bus bars. The two baths, which were compared successfully in the same tank and with all conditions duplicated, were prepared from technical salts with the regular compositions which were checked by analysis. The electrolytes were thoroughly agitated before each run but there was no agitation during an experiment.

TABLE V.

Specific Conductance.

Solution composition, 75 g./L. (2.55 *N*) nickel, 30 g./L. boric acid (0.48 *M*); temperature, 130 ± 0.1° F. (54.44 ± 0.05° C.); pH, 3.8 (quinhydrone electrode).

Fraction of Nickel Present as Chloride	Fraction of Nickel Present as Sulfate	Specific Conductance Reciprocal Ohms per Cm.
0.00	1.00	0.0755
0.055*	0.945*	0.0837
0.25	0.75	0.104
0.50	0.50	0.133
0.75	0.25	0.165
1.00	0.00	0.189

* Standard sulfate composition.

8. Hothersall and Hammond, Trans. Electrochem. Soc., **73**, 449 (1938).

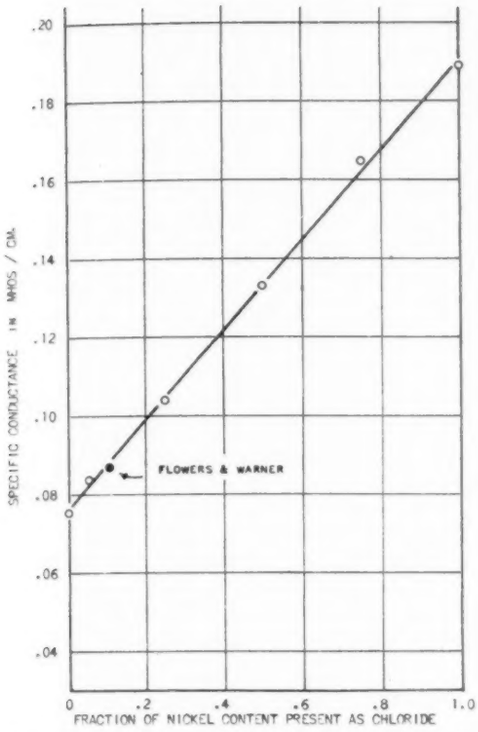

FIG. 9. Specific conductance of nickel plating baths. Nickel content, 75 g./L. (present as sulfate and chloride); boric acid, 30 g./L.; temperature, 130° F. (54.4° C.); pH, 3.8 (electrometric).

The tank voltages were measured with the aid of a voltmeter connected to the anode and cathode bus bars. Many of the readings were checked by connecting the voltmeter leads directly to the cathode and several of the anodes to make certain that there was good contact between the electrodes and the bus bars. Readings were taken after adjusting the current to successively lower values.

The results are presented graphically in Fig. 8. They show that the tank voltage, hence the power costs, for the sulfate bath are 2.0 to 2.2 times greater than those for the chloride bath under test conditions which can be considered representative of average commercial practice. The results also show that the maximum cathode current density obtainable under these conditions, with a 6-volt generator and the relatively large cathode, would be only 32 amp./sq. ft. (3.4 amp./dm.^{2}), whereas changing over to an all-chloride solution would permit use of current densities as high as 74 amp./sq. ft. (8.0 amp./dm.^{2}) at 6 volts.

Conductivity. The principal reason for the small tank voltages required with the chloride bath is that the specific conductance of this electrolyte is very much higher than that of sulfate baths. B. B. Knapp of this laboratory determined the specific conductivities of solutions of the same nickel and boric acid content but of different sulfate-to-chloride ratios. The apparatus he used consisted of an alternating current galvanometer, a Wheatstone bridge and an immersion-type conductance cell of dimensions selected to give a high resistance compatible with the low frequency (60 cycles) of current employed. The cell was made by sealing pure nickel electrodes on the ends of a 10 mm. glass tube 30.5 cm. long. Less polarization was observed when such electrodes were used than when platinum was tried. The cell was immersed in an oil bath which in turn was immersed in a water thermostat. The temperature of the electrolyte was thus controlled at 130° ± 0.1° (54.44° C. ± 0.05°).

The straight-line relationship in Fig. 9 indicates that the conductances of mixed solutions of nickel sulfate and chloride are additive. This also means that decrease in tank voltage is to be expected with increase in chloride content of a plating bath all the way up to the all-chloride solution. Waite[9] and Blum and Kasper[10] had shown that some of the characteristics of chloride deposits are obtained in full measure even when the chloride content is only 25 to 40 per cent of the total nickel salt content, but the conductivity data show one advantage of the all-chloride solution over baths containing sulfate.

The values of conductance of a solution 0.25 *N* with respect to Cl and containing 67.5 g./L. nickel instead of 75 g./L., as reported by Flowers and Warner,[11] were 0.0867 recip. ohm-cm. at pH 5.3 and 0.0882 at pH 1.9. From these a specific conductance of 0.0874 would be estimated for a solution at pH 3.8. This conductance is plotted in Fig. 9 and shows good agreement with the new curve.

It is interesting to compare the relative tank voltages in the regular sulfate bath and in the chloride bath with the ratio of the resistivities of these two compositions. The tank voltage ratio is between 2.0 to 2.2 whereas the ratio of the conductances is 0.0837:0.189, which is the reciprocal of the ratio of the specific resistivities of the two solutions and equals 2.26. The tank voltage at ordinary current densities seems to be largely determined by the resistivity of the bath. It is therefore to be expected that the power savings accomplished by replacing nickel sulfate with nickel chloride in a given plating solution will increase uniformly with increase in chloride content until all the sulfate has been replaced.

Cathode Efficiency. There are at least two ways in which the cathode efficiency of a plating bath can have an important effect upon its commercial use. First, if the cathode efficiency differs considerably from the anode efficiency, maintenance of a constant acidity or pH of the bath becomes difficult. Nickel plating baths are generally operated with soluble anodes and under conditions yielding very close to 100 per cent anode efficiency. It is desirable, therefore, to obtain a high cathode efficiency. Second, cathode efficiency may play an important role in determining the throwing power of the bath. In nickel plating solutions, cathode efficiency decreases with decrease in current density. It is obvious that a bath in which a large drop in current efficiency occurs as the current density is lowered will show poorer throwing power, other conditions being equal, than one in which the decrease is less precipitous.

Cathode efficiency determinations were made by E. J. Roehl with the aid of a copper coulometer. The nickel cell, similar in size and shape to the coulometer, was a 2-liter beaker 11.4 cm. in diameter equipped with a cylindrical anode of sheet nickel fitting against the wall of the cell. The cathode was a nickel-plated steel rod 12.7 mm. by 127 mm. in dimensions, coated at the top and

9. See footnote 3.
10. See footnote 2.
11. Flowers and Warner, Trans. Electrochem. Soc., **62**, 77 (1932).

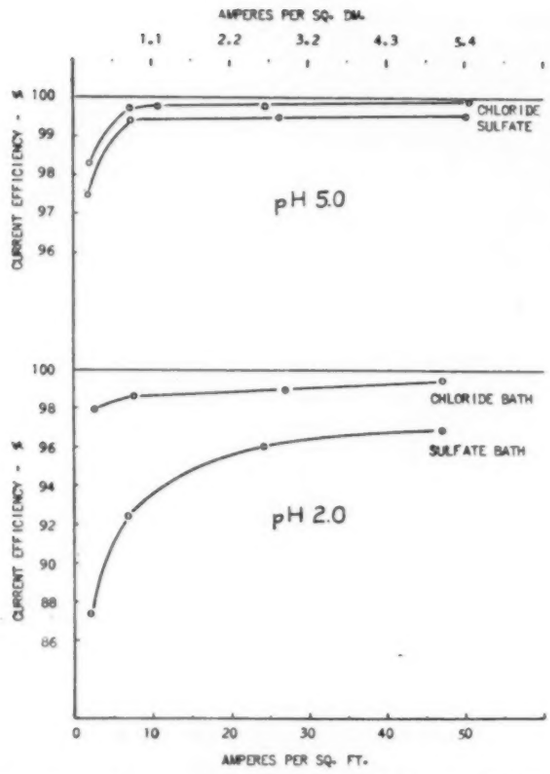

FIG. 10. Cathode current efficiency, 130° F. (54.4° C.).

bottom with a synthetic chlorinated wax resist, leaving exactly 102 mm. of the rod bare. The liquid level was adjusted in all cases to a depth of 108 mm. which covered the bare cathode area completely. Whereas the coulometer was operated at room temperature, the nickel cell was immersed in a constant-temperature water bath which maintained the solution at the desired temperature ± 1° F. (± 0.5° C.). The runs were 0.5 to 2 hours in duration, depending upon the current density used.

It should be noted that the use of a concentric anode and cathode occupying the full depth of the solution guaranteed an unusually uniform current density over the surface of the electrodes. The solutions were prepared to the standard compositions from chemically pure A. C. S. grade chemicals. No additions to prevent pitting were made to the solutions used in the cathode efficiency measurements.

The results are presented in Fig. 10 and show that, whereas the efficiencies in both baths are high at pH 5.0 and do not drop off much even at very low current densities, at pH 2.0 there is a considerable difference in favor of the chloride solution. This result was not unexpected because a few cathode efficiency measurements on all-chloride nickel plating solutions by other workers[12] have shown them to be superior to sulfate baths, especially at low pH values.

GENERAL DISCUSSION

The first question which will arise in the reader's mind upon learning the advantages of the nickel chloride plating bath is: why have not these advantages been discovered sooner and commercial use made of them? The answer is not obvious. As noted before, workers interested in refining nickel have never hesitated to explore the possibilities of a chloride electrolyte for this purpose. Perhaps the present use of sulfate electrolyte is chiefly due to the former lack of suitable materials of construction resistant to corrosion by the chloride solutions. Again, perhaps the worker interested in nickel plating has always been discouraged by the dark surface appearance of the chloride deposit. The refiner would pay little attention to this but much to the analysis of the product. Blum and Kasper[13] sought the most ductile deposit possible, hence abandoned the chloride bath for electrotyping even though their work demonstrated a number of advantages of that bath over the sulfate solution. Waite[14] also showed important advantages in high chloride baths but the scope of his work was limited by an experimental procedure in which deposits were made at only one pH value of each solution studied.

Advantages of Chloride Bath

1. *Low Tank Voltage.* The maximum voltage available with commercial generators of the type used in electroplating establishments is 12 volts. If it is attempted to operate a large nickel-plating tank at capacity, that is, with the cross-section of the bath substantially filled with work to be plated, the maximum current density which can be used is about 50 amp./sq. ft. (5.4 amp./dm.^{2}) since this requires a tank voltage of about 12 volts. This limitation has been noted by E. M. Baker[15]. Under the same conditions the chloride solution would permit the passage of over 100 amp./sq. ft. (10.8 amp./dm.^{2}).

The power cost can be cut substantially in half by changing over from the sulfate to the chloride bath. This cost is not considered an important factor in ordinary nickel plating as contrasted with refining. Nevertheless, the investment in generator equipment and its maintenance and repair are worth consideration even in the plating process. Professor E. M. Baker suggested to the authors that generators could be operated at considerably less than normal excitation, thus saving somewhat in brush and commutator wear and maintenance expense. Again, power costs become more important when heavy nickel deposits are made, as in electrotyping, forming and building-up worn parts.

2. *Ease of Buffing.* The greater smoothness of the fine-grained deposits from baths rich in chloride has been noted by Waite and by Blum and Kasper. Pinner and Borchert have reported that the costs of buffing decrease in actual commercial experience as the chloride content of the plating bath is raised. Qualitative tests made in connection with the present work with the aid of a polishing lathe employing 6-in. (15-cm.) polishing and buffing wheels indicated no marked difference between the dark matte deposits and the smoothest coatings from the sulfate bath but did demonstrate that the light matte and semi-bright deposits were much easier to polish. The semi-bright coatings 0.001 in. (0.025 mm.) thick were so smooth that they were readily brought to a bright, mirror-like finish without the use of cutting compounds and with only slight buffing on a soft rag wheel containing rouge.

12. Blum and Kasper, Trans. Faraday Soc., **31**, 1203 (1935); H. E. Haring, Trans. Electrochem. Soc., **46**, 107 (1924).

13. See footnote 2.

14. See footnote 3.

15. E. M. Baker, Trans. Electrochem. Soc., **59**, 383 (1931).

3. *Heavy Deposits.* The greater smoothness of thick deposits, lower tendency to form nodules, trees and built-up edges are attractive advantages of the chloride electrolyte for engineering uses such as electroforming and salvaging worn parts. For many of these applications the combination of an intermediate hardness with the high strength and satisfactory ductility of the deposit is much to be preferred over the physical properties of either very soft or very hard nickel. Ease of control of the bath, to be discussed, and lower power costs are important assets in making thick deposits.

4. *Ease of Control.* The composition of the chloride electrolyte is very simple, there being but two ingredients. The wide range of plating conditions under which sound deposits are obtained, the greater freedom from pitting and the high anode and cathode efficiencies all contribute to making this bath easier to operate and more nearly fool-proof than the sulfate electrolyte. Cleanliness is promoted by the fact that the chloride salts do not "creep" and form unsightly messes of green salt above the solution level.

5. *Freedom from Pitting.* It is possible that pitting will be encountered in operating large volumes of the chloride bath under commercial conditions but this was certainly not indicated in the laboratory work. Additions of oxidizing agent were required to prevent pitting only in freshly prepared baths, whereas daily additions were always necessary in plating from the sulfate electrolyte under identical laboratory conditions.

6. *Cathode Efficiency.* The cathode efficiency of the chloride electrolyte is higher than that of the sulfate solution under all the conditions investigated.

7. *Heating of Solution.* The heat generated when it is attempted to operate a sulfate solution with large amounts of work at very high current densities is so great that it may be necessary to use cooling coils in the bath. This is being done, for example, in a tank in which bumper bars are plated at 90 amp./sq. ft. (9.7 amp./dm.^{2}) in a commercial plant. This difficulty would not be encountered with a chloride bath until much higher current densities were employed.

Disadvantages of Chloride Bath

The principal disadvantage of the chloride electrolyte lies in the greater corrosiveness of the solution. Lead corrodes rather rapidly in it. A few years ago this would have been an overwhelming defect, but the present availability of rubber-lined steel for tanks and pipe-lines, as well as rubber linings or hard rubber for other parts of equipment, diminishes its importance. High-silicon iron can be used for pumps, heat exchangers and other cast parts.

For some uses, the fact that deposits from a chloride bath are harder and correspondingly less ductile than soft deposits from other baths would be a disadvantage. For most purposes, however, the greater toughness of the former would be an advantage.

The cost of nickel chloride and of hydrochloric acid (to adjust pH) is somewhat higher than that of the corresponding sulfates, but this would seem to be a minor part of the cost of electroplating.

Intermediate Chloride Concentrations

It may well be that further study of electrolytes containing both sulfate and chloride would disclose an intermediate composition which would be less corrosive than the chloride bath and productive of more ductile deposits, yet would retain to a large extent the advantages of the sulfate-free electrolyte. In any event, the present work indicates that the modern trend toward use of higher chloride contents in the Watts-type solution is a sound one and is to be encouraged.

Acknowledgment

The authors wish to express their gratitude for the aid of E. J. Roehl and B. B. Knapp of this laboratory who carried out some of the experiments described in this report.

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DISCUSSION

W. A. Wesley: There has been a general trend toward higher chloride concentrations in nickel plating solutions since Watts announced his bath[16]. Watts described his solution as having 32 oz./gal. (240 g./L.) of nickel sulfate, 3 (22.5 g/.L.) of nickel chloride and 3 of boric acid. When he made a survey of the progress of commercial use of the bath in 1930, the average of all replies he received showed 31 oz./gal. (232.5 g./L.) of the sulfate, 4 (30 g./L.) of the chloride and 3½ (26 g./L.) of boric acid. I made a rapid search through the literature of 1938, recording all references I could find to bath compositions for hot nickel plating. The resultant average composition for 1938 I found to be 37 oz./gal. (278 g./L.) of the sulfate, 6 (45 g./L.) of the chloride and 4½ (34 g./L.) of boric acid. There has evidently been a very steady trend toward an increase in chloride concentrations. The maximum that I encountered was 10 oz./gal. (75 g./L.).

16. Trans. Electrochem. Soc., **29**, 395-400 (1916).

L. Weisberg[17] (*Communicated*): Were the sulfate solutions purified in the same manner as the chloride solutions? The authors describe their method of purifying the chloride solutions and then go on to say that the sulfate solutions were prepared from C. P. chemicals, without stating whether or not the sulfate solutions were purified. In my experience, the use of C. P. chemicals has not always been sufficient safeguard against the introduction of deleterious impurities. If the sulfate solutions were not purified, it might account for their relatively poor showing, although it hardly seems that all the difference which the authors found can be attributed to this cause.

The point I wish to emphasize is that in investigations of this kind it is important to purify solutions very thoroughly. If that is not done, the findings are not likely to be applicable under the best conditions prevailing in industry, where careful purification is rapidly becoming the regular practice.

In this connection it may be observed that the procedure used in purifying the chloride solutions is not entirely adequate, since the authors report that new chloride baths required working for a short time before they stopped giving pitted deposits. Undoubtedly this period of working was required to eliminate some impurity that was not taken care of in the purification.

It may be pointed out further that the sulfate deposits selected for tensile tests and hardness determinations were plated under conditions which give the softest deposits. If these deposits had been plated from solutions having higher pH values, the difference in hardness would have been less marked.

17. Louis Weisberg, Inc., 71 West 45th St., New York City.

W. A. Wesley: The sulfate solutions were made from chemically pure salts. The chemicals were not subjected to further purification. As a matter of fact, some of the experiments, notably the conductivity measurements and the cathode efficiency determinations, were made as indicated in the paper from chloride and sulfate solutions both prepared from C. P. chemicals.

Dr. Weisberg's comments on the comparison with a soft sulfate deposit can

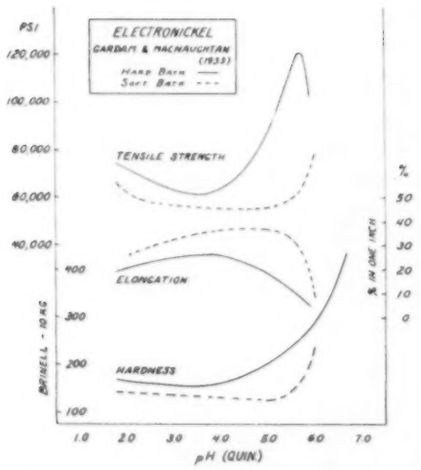

FIG. 11. Mechanical properties of electronickel (from Gardam & Macnaughtan)

	Hard Bath	Soft Bath
Nickel sulfate: g./L.	120	210
Nickel chloride: g./L.	...	30
Boric acid: g./L.	...	30
Ammonium sulfate: g./L.	8	...
Potassium chloride: g./L.	21	...
Temperature: °C.	35	35
Current density:		
Amp./sq. ft.	11	11
Amp./dm.^{2}	1.18	1.18

be answered by Fig. 11. Dr. Weisberg suggests that harder deposits can be obtained from the sulfate bath by plating at higher values of pH. These would compare more favorably in physical properties, he suggests, with the deposits from the chloride bath. The data of Gardam and Macnaughtan[18] summarized in Fig. 11 show that the hardness of nickel deposited from a sulfate solution does not change much with increase in pH until you get well above 5.5. Then it rises quite suddenly, so that you would find the bath unsuitable commercially for the preparation of deposits of a hardness of about 250 which would be required to give the tensile strengths shown by the matte deposits from the chloride solution.

COLIN G. FINK[19]: This is a type of paper that the Society welcomes. We have had numerous papers on nickel deposition from *sulfate* baths, but this is the only one on the *chloride* bath. I think the authors discourage using the chloride bath by their paragraph on disadvantages. Rubber-lined steel tanks are, of course, readily available today, but in our own laboratory we have been using chloride baths, various chloride baths, and we have used the cheapest cell construction you can think of, namely, a wooden tub and wooden barrels. There is only one precaution that we have taken with all of these acid chloride baths, and that is to load them down pretty much with sodium chloride. Adding an appreciable quantity of sodium chloride does not spoil a nickel bath. Have you had any experience in this regard?

W. A. WESLEY: No.

COLIN G. FINK: But the presence of the sodium chloride in the bath in relatively large concentrations makes it easy to handle in wooden cells, which are pretty cheap. I think you will find eventually that the chloride bath is a cheaper bath to handle than the sulfate bath.

G. B. HOGABOOM[20]: This paper is a valuable contribution to the electroplating industry. It would have been well, however, if a distinction had been made between ornamental plating and heavy nickel deposits such as Dr. Wesley has described in a previous paper[21]. The effect on the deposited metal of metal impurities in the solution, especially iron, is of importance.

Dr. Wesley calls attention to the corrosive property of the nickel chloride solution and recommends rubber-lined tanks and protected equipment. If steel articles having deep recesses, or hollow tubes and similar articles are put into the nickel chloride solution there will no doubt be an attack on the parts not receiving the electrodeposited nickel, and iron will be taken into solution. It is generally accepted that iron is one of the contributing factors in pitting of nickel deposits.

Vuilleumeier found that iron in a nickel solution contributed to the "peeling" of the deposit, and even small amounts caused a marked contraction of the nickel deposit which he measured by a contractometer.[22] When the nickel solution had no iron present, the needle on the dial of the contractometer deflected only 4 mm. in 20 min. When the iron content was equivalent to 1 g./L., the needle raced to 26 mm.[23]. Such a deposit may be brittle and the adhesion to the base metal would be poor. If, as is often required today, the nickel deposit was chromium-plated, then there is the probability that the nickel would "peel."

Small amounts of copper or zinc in a nickel solution will cause the nickel deposit to be very dark and tend to be brittle. As little as 0.01 g./L. of zinc has a bad effect on a nickel coating.

Fink and Rohrman described a method of purifying a nickel electrolyte by electrolysis that is now in general use[24].

Both steel and brass are chemically attacked in the nickel chloride solution more rapidly than in a nickel sulfate solution, *e.g.*, the Watt's solution. The attack is four times as rapid.

It is only in recent years that nickel anodes of high purity could be had. Iron was added to nickel up to, at one time, 8 per cent which, no doubt, prevented the adoption of the nickel chloride solution.

For heavy nickel coatings to build up worn parts of machinery, or for heavy deposits where special protection against chemical attack is required, Dr. Wesley's solution will prove of much value.

COLIN G. FINK: Many of the difficulties Mr. Hogaboom has cited largely disappear upon loading the bath with sodium chloride.

J. W. CAREY: We were not attempting to deprecate the sulfate bath, but were rather trying to show the utility of the chloride bath. We did not make an intensive investigation of the sulfate solution because that has been done before.

F. J. VOSBURGH[25]: The authors mention the use of hard-rubber, rubber-lined and high-silicon-iron equipment. Impervious carbon and impervious graphite, Karbate No. 1 and Karbate No. 2, are also entirely resistant to these solutions at all of the used temperatures, and these materials are available in pipe form and in plates.

F. C. MATHERS[26]: The statement was made that impurities in the bath are deposited out with the nickel. Some impurities even in very small amounts have large effects on the deposit. We know that a great many substances present in the bath are deposited out with the metal on the cathode. That is true of ordinary organic addition agents, and it is also true of chloride and other halogens.

COLIN G. FINK: How about basic iron salts?

F. C. MATHERS: I do not know of any data concerning the deposition of such iron salts. However, I believe that complex cations are deposited, and we have some data supporting that theory. The old example is the explosive antimony deposited from a hydrochloric acid solution of antimony chloride. There is a high percentage of chlorine in such deposits. Some time ago a paper before this Society showed that bromine and iodine were present in cadmium deposits made from the corresponding cadmium solutions[27]. Halogens are much the best for such experiments because of the accurate and satisfactory analytical methods. I think that many of the various substances present in the baths are deposited at the cathode and become a part of the metallic deposit. Have the authors made any tests for the presence of chlorine in their cathode deposit?

W. M. TUCKER[28]: We have verified Dr. Wesley's results, using commercial salts in both the nickel chloride bath and the Watt's-type comparison bath. The method of purification prior to plating was identical for both baths and was a variation of the Liscomb method recommended by

18. Trans. Faraday Soc., **29**, 755 (1933).

19. Head, Division of Electrochemistry, Columbia University, New York City.

20. 557 Stanley St., New Britain, Conn.

21. "Physical Properties and Uses of Heavy Nickel Deposits," Proceedings, Am. Electroplaters' Soc., June (1938).

22. "Application of a Contractometer to the Study of Nickel Deposition," Trans. Electrochem. Soc., **42**, 99-107 (1922).

23. E. A. Vuilleumeier, "Peeling of Electrodeposited Nickel," Proceedings, Am. Electroplaters' Soc., June (1932).

24. "Preparation of Pure Electrolytic Nickel," Trans. Electrochem. Soc. **57**, 325-38; **58**, 403-20 (1930).

25. National Carbon Company, New York City.

26. Professor of Chemistry, Indiana University, Bloomington, Ind.

27. E. Tesche and P. J. Van Rysselberghe, Trans. Electrochem. Soc., **59**, 353-7 (1931).

28. Roll Coating Dept., Eastman Kodak Company, Rochester, N. Y.

Dr. Weisberg. Since our results were essentially the same as Dr. Wesley's, it seems that Dr. Weisberg's concern about the unpurified, chemically pure salts used in the Watt's-type comparison bath is unjustified in this particular case.

E. M. BAKER[29]: It is improbable that the bath, purified as described by the authors, would contain a sufficient amount of impurity to affect the conductivity measurements. It is possible that minute amounts of impurity may have been present and may have affected the porosity of the deposits. Additions of an oxidizing agent were required to prevent pitting in freshly prepared baths.

I see no disadvantage in the requirement of using a rubber-lined plating tank. Most of the large commercial tanks in use today for nickel plating are rubber-lined.

Iron actually co-deposited as metal with nickel should not affect the rust resistance. However, ferric iron in the solution will usually be precipitated at the pH existing in the cathode film. This ferric hydroxide may be included in the deposit and thus increase the porosity and reduce the protective value of the plate.

COLIN G. FINK: Would you not be more likely to get chloride inclusion in the presence of iron salts?

E. M. BAKER: I think that is true

Do the authors believe that the hardness of their deposits is due to the inclusion of hydrate, presumably nickel hydrate, or do they believe that the hardness is due primarily to the small grain-size of the nickel deposited? The work of a number of English authors, particularly Macnaughtan, Gardam and Hammond[30], indicates that the hardness of nickel deposits is increased primarily by the presence of nickel hydrate which has been precipitated in the cathode film and is included in the deposit. In this case the fact that you have exceptionally high cathode current efficiencies would indicate the probability of more inclusion of hydrate in the deposit than would occur from the Watt's sulfate bath.

H. P. COATS[31]: I do not know of any rubber company selling rubber-lined tanks at less than $2.50 per sq. ft., and some are charging $5.00 a sq. ft.; the lead linings can be obtained for less than half of that.

COLIN G. FINK: I'll go back to my wooden pail—you can't beat that as to cost.

W. A. WESLEY: We certainly appreciate Mr. Hogaboom's discussion with its many interesting comments. He has warned us of troubles we can anticipate if we put this bath into commercial practice, and it is certainly better to be forewarned than not. He was kind enough to tell us about the increased danger of corrosion of iron and of brass some time ago and Dr. B. B. Knapp of our laboratory ran some corrosion tests involving no electrolysis, with the specimens moving at the rate of 16 ft. (4.9 m.)/min. and immersed in either the standard chloride or the sulfate bath. The solutions were saturated with air, the pH of each was 2.0, and the temperature 60° C. The weight losses observed at the end of a 20-hour test were as follows:

	Mg./dm.²/day			
	Mild Steel		Copper	
In sulfate bath	268	254	618	621
In chloride bath	420	392	1.300	1,280

It is interesting to note that copper corrodes more rapidly than steel in these well-aerated plating solutions. The reverse would be true if the solutions were free from air.

It is evident that the rate of attack of steel or copper when not protected by a cathodic current is about twice as great in the chloride solution as in the sulfate bath. That means that in operating the chloride solution for ornamental plating, all conditions being the same, the iron or copper content of the bath would build up at only about twice the normal rate observed in using the Watts bath.

Professor Baker suggested that the physical properties of the thinner deposits should also have been determined. The paper describes one attempt at that, namely, the Erichsen ductility tests. These showed no great discrepancy with the measurements of ductility of the thicker deposits. The porosity tests were made with deposits only 0.001 in. (0.025 mm.) thick.

(*Communicated*): We thank those who discussed our results for their interesting comments. There were several questions they raised to which it was not possible to reply in the oral discussion, due to time limitations.

The effects of impurities were discussed at some length. In our experience with the chloride bath to date, both in small-scale and in semi-plant-scale plating, we have not found it to be any more difficult to purify or to maintain in good operating condition than any other nickel bath.

Mr. Hogaboom suggested that the conditions which were selected as standard for deposition from the sulfate bath were not compatible with the optimum conditions of operation at low pH, as determined by W. Phillips[32] in 1930. As a matter of fact, Phillips' work was considered in planning these tests. Allowing for the fact that our sulfate composition was much higher in nickel content than Phillips', we believe that the conditions chosen not only do not conflict with his recommendations but also represent good practice in operating the Watts-type bath. The nickel content of both sulfate and chloride baths was high, namely 10 oz./gal. (75 g./L.).

In answer to Professor Mathers' question, we are sorry to say we have not made an analytical determination of the amount of chloride present in deposits from the chloride bath. He will be interested to learn that the best method for preparing spectroscopically pure malleable nickel is to deposit it with the aid of insoluble anodes from a solution of nickel chloride[33].

It was particularly gratifying to learn that Mr. Tucker's results with a bath purified by commercial methods were essentially the same as ours.

We believe with Professor Baker that the higher hardness of the deposits made from the chloride bath is due primarily to inclusion of more nickel hydrate. In accordance with the theories of Macnaughtan, Gardam and Hammond[34] one would expect the sulfate and chloride ions of the two baths to have quite different effects upon the occlusion of colloidal basic nickel compounds in the cathode deposit. Their results showed that small amounts of chloride added to a sulfate bath caused reduction in the hardness of deposits. The presence of large amounts, however, reverses this tendency, as shown by Blum and Kasper[35], and by the work under discussion. Much remains to be learned about the mechanism of the colloidal processes involved at the cathode in nickel plating.

29. Consulting Chem. Engr., Ann Arbor, Mich.

30. Trans. Faraday Soc., **29**, 729 (1933).

31. Firestone Tire & Rubber Co., Akron, Ohio.

32. Trans. Electrochem. Soc., **58**, 387 (1930).

33. Fink and Rohrman, Trans. Electrochem. Soc., **58**, 418 (1930); van Arkel: "Reine Metalle," p. 351, Berlin (1939).

34. See footnote 33.

35. Trans. Faraday Soc., **31**, 1203 (1935).

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Joining Thin Tubing to Cast Brass

In making an immersion type urn heater, the Harold E. Trent Co. of Philadelphia had a problem of joining eight flat tubes to a cast brass center. The tubes, as illustrated in this case, are copper, but to meet some conditions a steel alloy tube is used. An electrical heating unit must be assembled inside the tubes before the joint is made. After fluxing the brass center and the tubes, the unit is assembled on a frame or jig and heat is applied with a torch. There are 16 joints to be completed which normally have to withstand pressures up to 100 lbs. per square inch and stay leak-tight under conditions of repeated heating and cooling. The thin section of the tubing makes it desirable to keep the heat for making the joints as low as possible. The brazing alloy used, Easy-Flo, was selected because of its low flow point—1175° F.—and because its silver content assured a ductile joint and strength as high as the tubing. By concentrating the heat on the heavier cast brass center, joints are made without damage to the thin metal tubing. As the center section reaches a dull red heat, the brazing alloy is applied to the joint and the heat is shifted momentarily to the tubing to assure a uniform brazing heat. The finished joints are smooth and even, requiring no finishing work. The same brazing alloy is used on both the copper and steel alloy tubing. The free flowing and rapid penetration of the brazing alloy make this a fast and economical method of doing this difficult job.

A Handy Horizontal Tank Chart

By W. F. Schaphorst, M. E.

Here is a chart that gives the gallons of liquid in any horizontal tank without the use of tables, formulas, figures, or computations of any kind.

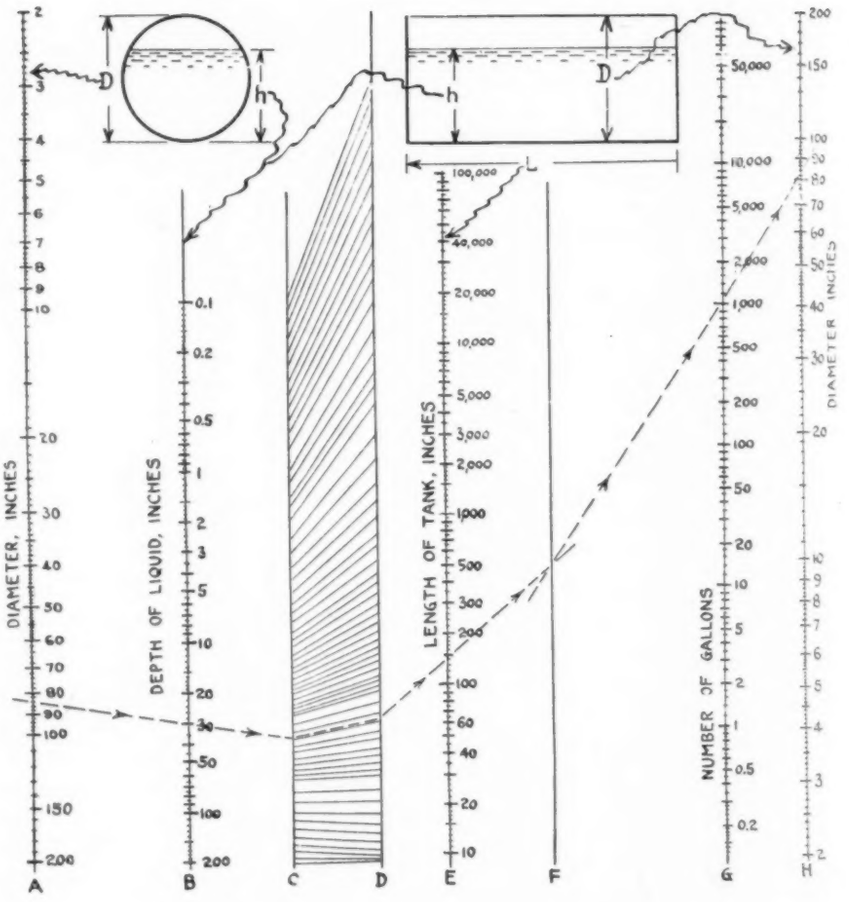
Simply start at the left and zigzag a ruler or thread across the chart three times as demonstrated by the dotted line and the number of gallons is immediately found in column G. For example: How many gallons in a tank 84 inches in diameter, the depth of liquid being 30 inches, and the length of the tank being 142 inches?

Run a straight line through the 84, column A, and the 30 in column B and locate the intersection with column C. By means of the eye follow the radiating "guide lines" to column D, locating a second point of intersection. From this latter intersection, run through the 142, column E, and locate the point of intersection in column F. Then from this point run over to the 84, column H, and the intersection in column G will be found to be close to 1,050 gallons, which is the answer.

One of the great advantages of this chart is that it takes care of any depth of liquid from 1/10 of an inch to the full capacity of the tank. To make the chart absolutely clear, the writer has included sketches showing the diameter of the tank D, the depth of liquid H, and the length of tank L with wavy arrows leading from them to the proper columns. By following them no mistake can be made.

The range of the chart is amply wide. It will take care of any diameter from 2 inches to 200 inches and of any length of tank from 10 inches to 100,000 inches.

This chart will give an answer much more quickly than tables for



formulae. It is surprisingly accurate. It is more complete than tables because it takes care of every dimension between 2 inches to 200 inches whereas tables generally skip many diameters and lengths giving only 24", 28", 32", 34", etc.

To avoid confusion all dimensions are given in inches.

Since column E takes care of lengths of tanks up to 100,000 inches, it is plain that not only will this chart compute tanks but it will include long pipes whenever it is desired to compute either the full capacity of such pipes or their partial capacity. 100,000 inches is equal to 8,333 1/3 feet.

Inversely, the chart may be used very conveniently for determining the length of tank necessary to hold a given number of gallons where the diameter of tank and depth of liquid are known or fixed quantities as is often the case. The method of applying the chart to problems of this character is so obvious that further directions are unnecessary.

Repair Welding, Brazing and Soldering of Light Metal Castings

By Edmund R. Thews

Consulting Metallurgist
Berlin, Germany

Reference has been made in the February installment of the pronounced heat expansion and contraction of light metal alloys. It is obvious, for this reason, that if welding is carried out without preheating of the casting, the welding heat is rapidly conducted away from the weld section so that when the welding process is completed it will tend to cool off and contract correspondingly rapidly. At the same time, the casting itself, which originally was at a much lower temperature, still takes heat from the hot weld section, resulting in the expansion of the casting proper while the weld section contracts. The thermal stresses thus set up are based on irrefutable physical laws and even the best of welders is unable to measure his sublime skill against this fact.

Preheating of castings for repair welding thus represents a necessity regardless of type, size or shape of the castings. The only question remaining is the selection of the proper kind of heating adapted to every individual case. Small castings weighing up to 1 or 2 pounds each can be preheated with a soldering torch in a manner calculated to effect absolutely uniform heating of the entire castings. Larger pieces up to 10 or 15 lbs. (depending on the general equipment of the foundry) can be preheated on simple, primitive arrangements such as a steel plate heated from beneath, with asbestos plates surrounding and covering the castings in order to attain a maximum of thermal uniformity. The larger the castings involved and the more complicated and intricate their shapes, the more substantial and carefully arranged should be the apparatus employed for this purpose.

Preheating Furnace

It is not necessary, however, to spend large investments on furnaces of this type. The author designed the preheating furnace indicated in the Figures No. 1 and 2 showing longitudinal and cross sections of the construction. It is well known that at the preheating temperatures in question, which range between 600° and 750° F., depending on size, composition and shape of the castings, the strength and hardness of the latter have suffered considerable reductions. If during this period, the castings (especially of the complicated, heavy types) are handled without extraordinary care, fractures or sectional overstressing will result, the latter being the more dangerous alternative if it proceeds unnoticed. Whatever the preheating system selected, therefore, it is absolutely necessary to leave the preheated casting in its original position and to place it beforehand into a position permitting of the welding manipulations without moving the casting.

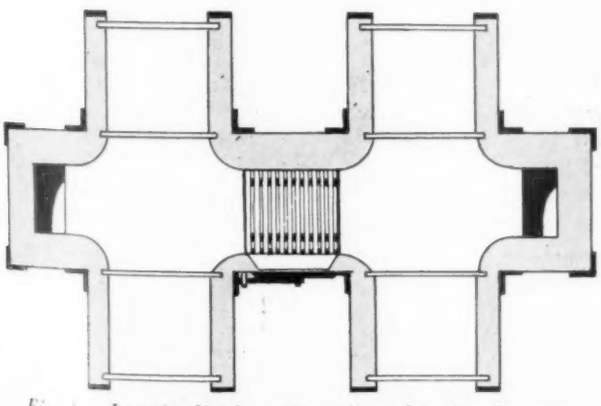


Fig. 1. Longitudinal section of pre-heating furnace.

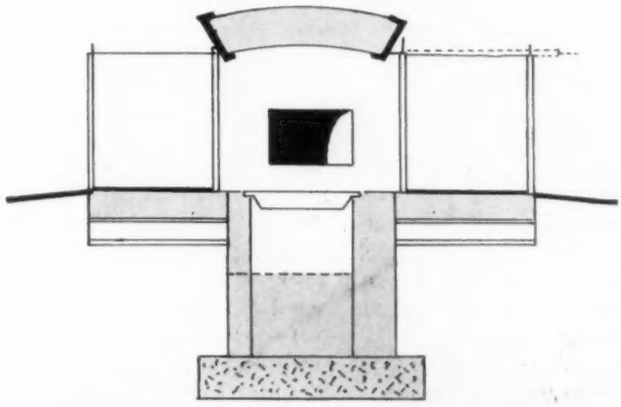


Fig. 2. Cross-section of pre-heating furnace.

It appears clear from the above description of my furnace that in view of the delicacy of the mechanical properties of aluminum castings at the preheating temperatures involved, the primitive arrangements indicated above should be avoided wherever possible, unless the character of the production is such that repair welding represents an isolated occurrence. It is even advisable in such cases to construct a small heating arrangement with only one chamber along the lines indicated by Figures 1 and 2 and adapted to individual requirements.

Another extreme is represented by castings which due to their enormous size cannot be handled in a way permitting the use of furnaces of any normal size or type. Castings of this size are very expensive, of course, and a certain amount of preparation costing a fraction of one per cent of their value may then be justified. Large chambers heated by waste gases resembling, in principles, large annealing chambers can be used, the castings being transported into these chambers on suitable bogies. If the rolling gear of these vehicles operates sufficiently smooth and soft, no internal stresses will be induced within the casting by the transport into and out of the preheating chamber. The excessive radiation of heat from the large castings during the welding operation can be overcome by a number of measures including asbestos aprons, etc. It is also possible to protect the welder's stand with asbestos boards, leaving only sufficient space for his arms, etc. Where the castings are so large that even this alternative is impossible, or where suitable chambers are not available, local preheating may remain the only choice. This can be effected with the soldering torch and should extend over as large an area as possible—eventually by two men. The effect of this treatment should be to obtain as gradual a decline of temperature from the weld section toward the outside as possible in order to minimize the possible stress effects as much as possible.

Welding Procedure

The welding process itself is started by covering the welding section with a little flux and heating the surfaces up to welding heat. If the faults have not been cut out previously, they are now cut out with the torch using a steel tool of about ⅛" diameter having one flattened and sharpened end, straight or bent into a suitable angle, while the other end is shaped into a handle. The weld is thus fused and scratched out until all metallic surfaces are perfectly clean, the most preferred shapes of the cavities being open or inverted Vees. The author prefers the second or "swallow tail" recesses which doubtlessly yield a better "hold" and tighter joints than the V-ing cuts. The opinion that maximum adherence must be obtained without this "trick" is beside the point. If closing a Vee and a swallow tail cut is effected with equal care and precision, the latter will be more satisfactory beyond doubt, and that is the goal to aim for. Another question is the attitude of the customer who actually may wish to see a trick in the swallow tail cut with a view to cover up possible shortcomings of the welding operation. If the customer insists on the Vee, his will be done, but the swallow tail cut is the most advantageous if quality is the only consideration.

Welding proper is commenced by fusing a little metal from the inner surfaces of the cut. The tip of the rod covered with the flux paste is held into the bath thus formed and gradually fused by holding the tip of the neutral flame on to the bath (not against the rod). The lower end of the rod is now moved to and fro against the submerged surfaces of the cut producing intimate contact between the solid and fused metal. Care must be taken to heat the fused metal to a temperature just above fusion temperature in order to avoid overheating and spoiling of the weld metal. If the temperature rises to bright red heat, the flame is removed and rubbing of the rod within the bath continued until enough rod metal has been melted off to reduce temperatures to a desirable degree.

The above comments apply to weld sections of up to about 3 inches length. Still longer welds should be effected in stages of about 2½ to 3 inches each. After finishing the first sector, the hot weld is permitted to cool down to about 600° F.; the next sector is then cut out and welded as described.

After finishing the work, it is absolutely necessary for the purpose of homogenization of the structure to let the casting cool down as gradually as possible. Where preheating furnaces are not available, the welded casting should be surrounded and covered with asbestos board so as to retain the heat as long as possible.

The question of the suitability of the various types of welding flames is of lesser importance. It appears that in the U.S.A., oxy-acetylene flames are preferred, while in England and on the Continent, oxy-hydrogen and oxy-methane flames are usually employed on account of their softer heat (preventing superheating of the fused metal) and because of the fact that their path can be observed without smoked glasses. The hotter flame of the oxy-acetylene torches which forms an advantage of this type of flame in the welding of copper and copper alloys or possibly even of aluminium and aluminum alloy sheets and plates is of no importance whatever in repair welding of preheated aluminium alloy castings.

It is frequently possible, or necessary, in the case of deep crevices caused by cutting out pipes, cracks, misplaced bore holes, etc. to fill up the holes with molten metal of correct composition without going to all the trouble connected with regular welding operations. After preheating the casting to a suitable temperature, the weld section is cut out as described above (unless this was effected previous to preheating). While for ordinary welding processes, the author is in favor of previous cutting, he prefers subsequent cutting in this latter instance because of the fact that part of the metal removed from the crevices should be pulled upward and left on the top edges so as to form a dam of metal about ¼" to ½" high all around the crevices. The hot bottom and sides are then sprinkled with flux powder and fused metal superheated to 1450° F. is poured in until it fills the hole up to the top of the dam (in order to collect all bubbles, dross, etc. into the excess top layer machined off after welding). In order to ensure perfect adhesion of the weld metal to the walls, the metal should be puddled with the preheated steel tool and the sides and bottom of the recess scratched so as to remove all oxide films which may possibly have formed in spite of the fluxing operation.

The casting is then permitted to cool off as slowly as possible and the excess metal machined or ground off as required.

The matter of subsequent heat treatment appears to be of theoretical importance only. It has been argued that in spite of all precautions, the process of welding is bound to introduce thermal stresses within the casting, and these can be removed only by suitable heat treatment, i.e. by annealing the casting to a temperature of, say, 850° to 900° F. The author and others found that if the welding process has been carried out with due care and attention to detail, no subsequent annealing treatment is required. Full thermal equalizing effects could be obtained only within a range of 950° to 1000° F. in any case, and these temperatures are so near the danger range (overheating) that the disadvantages risked by this treatment overweigh the possible advantages by far. In any case, a temperature of 900° F. should not be exceeded.

Brazing

It may sometimes be considered necessary or advantageous to carry out the repairing of light metal castings at temperatures lower than those required for welding. This is the case where suitable equipment for preheating or welding is not available and where general conditions seem to be adverse to the subjection of (delicate or complicated) castings to elevated temperatures. If repair brazing of these castings is carried out correctly, there really is very little practical difference between welded and brazed repairs, with the possible exception of corrosion resistance toward certain corrosion agents accidently influenced by the difference of composition between the light metal castings themselves and the brazing alloys which contain a certain percentage of metals such as tin and zinc calculated to reduce the brazing temperatures to the ranges adapted to this process.

It is usually specified that brazed sections must exhibit values for tensile strength, elongation, elasticity, notch resistance, etc. substantially the same as those of the light metal castings themselves, i.e. the brazed casting must resist the same stresses as the corresponding sound castings. They must also react similar to all finishing treatments including machining, milling, filing and grinding. As a rule, the workability of brazed sections is clearly better than that of the light metal castings themselves. The fusion temperatures range from 750° to 1100° F., depending on conditions and specifications, and the temperature resistancies of the brazed sections, while lower as a rule than those of the castings, suffice entirely for the purposes for which the latter are used. If comparatively high operating temperatures are actually required, it is possible to select brazing alloys melting at 1050° to 1100° F. which are as resistant to elevated temperatures as any light metal alloy castings yet produced.

Attention should, in this connection, be called to the fact that if the castings are to be subjected to elevated temperatures for long periods, alloy diffusions will take place in the course of time, especially along the boundaries of the brazed sections. If, now, the brazing alloys are composed so that the influx of certain other metals into these alloys deteriorates the technical properties of the brazing alloy, the latter obviously is unsuitable. Indeed, it is much preferable in cases of this type either to weld the fault with an alloy composed exactly like the casting itself or to scrap the casting. *Welding must not be carried out for its own sake but should be applied only where it is the better alternative technically and economically.* The same applies to brazing and soldering for repair purposes.

A certain amount of diffusion will take place during brazing in any case and doubtlessly is advantageous or even necessary for perfect results. Experience has shown that the depth of diffusion or penetration may occasionally reach 1/8" to 1/6", depending on the brazing alloy used, brazing temperatures, composition of the castings and the length of brazing period. Experiments have shown that within a brazing period of about 20 minutes and at a high brazing temperature of 1100° F., the depth of diffusion easily reaches 1/8" while if for one reason or another, this period is exceeded, this depth may reach even 3/16". It is obvious for this reason that in order to avoid disagreeable changes of technical properties within this boundary range, the composition of the brazing alloy should also be considered from this point of view.

Composition of Brazing Alloys

Exact compositions of the brazing alloys usually are secrets of every one believing to be in possession of the best ones. Practically all of them contain 70 to 95 per cent of aluminum and 30 to 5 per cent of alloying constituents including particularly copper and tin. Many alloys of this type also contain zinc and bismuth while a number of brazing alloys contain some antimony as well. In order to obtain minimum melting temperatures in spite of the high aluminum contents, it is a general practice to use as many alloying constituents as possible even if their total percentage is relatively small. Some of these alloys contain as many as 6 to 8 alloying constituents besides aluminum, the average being about 5 to 6 metals. Three aluminum-rich alloys of this type have the following composition:

Composition of Brazing Alloys

	I	II	III	
Aluminum	95	95	95	per cent
Copper	1	1	2	"
Tin	4	1	1	"
Zinc	...	1	...	"
Bismuth	...	2	1	"
Antimony	...	...	1	"

Brazing Fluxes

The *fluxes*, which are always required in connection with repair brazing and welding of light metal castings, are composed of mixtures of chlorides and fluorides of the alkaline, alkaline earth and straight earth metals and frequently contain the corresponding lithium salts as well. A typical flux of this type contains 45 per cent potassium chloride, 30 per cent sodium chloride, 15 per cent lithium chloride, 7 per cent potassium fluoride and 3 per cent potassium bisulphate.

A very necessary, but frequently neglected, condition is the complete removal of even traces of the fluxes after welding. It does not suffice to merely wash the finished weld with cold water since many of the flux materials

used for this purpose are but slowly soluble in cold water. Hot water or steam should be employed in connection with a long handled brush to remove the last traces of this material. Efflorescence, developed after some time of usage of the castings, usually indicates insufficient washing, instead of galvanic corrosion effects due (as is frequently claimed by the brazers themselves) to unsatisfactory composition of the brazing or welding metal. It is often found beneficial to dry the washed and cleaned section carefully and to apply a thin film of linseed oil or some other neutral oil, while rubbing the surface of the section with paraffine wax is also claimed to yield improved results.

If all the above described precautions are observed, repair brazing usually is fully as satisfactory as welding with respect to mechanical as well as chemical properties. Indeed, experience has shown that for the light metal alloys of the aluminum-copper and the aluminum-zinc groups, brazing is distinctly more advantageous than welding, even if the latter is carried out with exactly the same alloy as the casting itself.

Corrosion Resistance

The corrosion resistance of the brazing alloys is satisfactory, although not quite as good as that of welding metals. On account of the high aluminum contents (from 60 to 90 per cent) the difference of potential between the brazing alloys and the castings themselves is very small, amounting to 0.02—0.1 volts. Much depends upon the choice of alloys and general corrosion conditions, but it can be stated that brazing alloys containing comparatively small percentages of copper (i.e. between 2 and 4 per cent) yield more resistant brazings than the groups containing 5 to 10 per cent of copper. It is natural that the difference of reaction to corrosive agents changes with increasing temperatures and that short heatings to comparatively high temperatures may change the corrosion resistance of the brazing alloy forever. All these points must be considered when selecting brazing alloys for the purposes involved. Loosening of the brazing section due to elevated temperatures is a very rare occurrence, but it does not take place at temperatures below about 950° F.

The mode of application of the repair brazing process does not differ in any important respects from the corresponding welding process. Preheating need not be to so high a temperature, but even this factor is not of governing importance.

Soldering

While welding and brazing of light metal alloys are employed with equal advantage to cast and wrought metals (brazing being somewhat better suited for the former and welding for the latter varieties), soldering is reserved almost exclusively for aluminum and light metal castings. It is realized that repair soldering exhibits considerable disadvantages, but the ease and simplicity of application characterizing this mode of repairing light metal castings renders this process the most advantageous where the mechanical and corrosive strengths of the castings need not exceed a certain low average.

The strength values of the soldered sections of castings are bound to be comparatively low for two reasons: (1) The adherence of the soldering alloys can only be superficial even if the constituents of suitably composed solders are able to form solid solutions with the aluminum alloys by diffusion. (2) The zinc or tin alloys used for this purpose are relatively non-noble and correspondingly sensitive to corrosive influences—unless properly protected. (3) Due to the easy oxidation of these alloys, especially if subjected to the normal soldering temperatures (400° to 750° F.), oxide impurities within the soldered sections must be guarded against by suitable manipulations. (5) On account of the difference of electrolytic potentials between the light metal casting and the heavy metal solder, galvanic elements are formed at the boundary between these metals which, in the presence of an electrolyte including atmospheric agents, are bound to lead to decomposition lowering not only the tensile strength and the general corrosion resistance of the soldered sections but possibly also to the complete destruction of the solder. (6) Aluminum exhibits a tendency toward the formation of decomposable metallides, etc. which intensify the electrolytic, or galvanic action mentioned above. It has been practically impossible as yet to find alloys answering the general requirements of solders used for this purpose, besides withstanding the effects of the two influences (5) and (6), and statements or claims to the contrary can be discounted without compunction. Even the copper-tin alloys of specifically fixed compositions recently suggested for this purpose are no answer to the foundrymen's prayer, and if the influence of different electrolytic potentials on corrosion still holds good, it is hard to see how alloys composed of known metals and answering the general requirements placed in light metal solders can get around fixed physical laws. It may be possible, perhaps, to develop some process of soldering reducing the rate of corrosion by certain or all corrosion agents, but the selection of different alloys can only have limited qualitative results.

Innumerable alloys have been developed and employed for this purpose although few really good improvements have been made since first these soft solder alloys were introduced by Thowless about 1885, although the silver frequently added in those days has now been abandoned completely, its practical value being nil, while raising the softening temperatures considerably. The so-called Richards' solder (originally patented by Richards—USA Patent No. 478,238) originally contained 78.3 per cent tin, 19 per cent zinc, 2.4 per cent aluminum and 0.25 per cent phosphorus (added as phosphor-tin). This mixture was later changed to one containing 71.5 per cent tin, 27 per cent zinc, 2.5 per cent aluminum and 0.3 per cent phosphorus, the last constituent being added to prevent the formation of surface skins. There are many tin-rich solders for the repairing of light metal castings to-day which differ in no respect from this alloy.

While the quality of these alloys is as satisfactory as possible in view of the characteristic properties of all these alloys, they proved to be rather expensive for many purposes on account of their high tin contents. In Central European countries this disadvantage has been felt more poignantly than in England and the United States. It was found that the zinc contents could be raised considerably without lowering the general properties of the solder con-

siderably, although the resistance to corrosion naturally was reduced thereby. Some alloys of this type such as the French Noiret solder contain as high as 80 per cent zinc and only 20 per cent tin, but these are unsatisfactory, the most common range of modern alloys of this type being about 15 to 50 per cent zinc, up to 25 to 30 per cent tin and some aluminum and copper, while some of these alloys contain small quantities of nickel, lead, cadmium, bismuth, silicon and antimony. Lead must not be present in percentages of more than 3 per cent including bismuth, the maximum percentage of cadmium being 5 per cent. Where tin is scarce, or where special adherence is desired, the zinc contents may rise to 90 per cent. The more pronounced degree of adherence of the zinc-rich solders is due to the formation of Al_2 Zn_3—compound. However, this compound is not stable at lower temperatures. It is formed only at temperatures of about, and above 500° F. and decomposes on cooling below 490° F. Improved adherence still remains in spite of this decomposition, but the expansion caused thereby frequently spoils the work.

Zinc-rich solders usually are applied in a paste or semi-paste state consisting of a fluid melt and solid crystals, especially where the zinc or aluminum contents are comparatively high or where low melting constituents are comparatively rare. A much used alloy of this type is represented by the Wuest's solder containing on an average about 50 to 65 per cent zinc, 20 to 30 per cent aluminum and 15 per cent copper.

The tin-rich solders, on the other hand, exhibit better fluidity and higher corrosion resistance against many corrosion agents. They are also much more easily applied and more durable than the zinc-rich solders, although all these factors are greatly influenced by the mode of application as well as by the kind of use (corrosive influences, etc.). It is obvious that in machine castings, covered by oil throughout and at all times, the durability of zinc-rich solders will not be much less than that of the tin-rich types. The better appearance of aged tin-rich solders also does not count for much under circumstances like this, while on account of the higher degree of adherence of zinc-rich solders of the Wuest type its usefulness may actually be much greater than that of the much more expensive tin-rich alloys.

Impurities in Solders

Very much depends on the presence of small impurities in both groups of solder alloys. Impurities of this type are magnesium and iron—even if these elements are added intentionally. Magnesium forms the compound $Al_2Mg_2Zn_6$ with aluminum and zinc, while iron constituents form the compound $FeAl_3$ with aluminum. It is well known that both of these compounds are as brittle as they are sensitive to corrosion and their presence in light metal solders therefore is bound to deteriorate the general technical properties of these metals. Copper, on the other hand, increases the adherence of these solders if aluminum is also present, the compound $CuAl_2$ formed by these two constituents adding much to the solvent capacity and diffusibility. The softening or melting temperatures of the tin- and zinc-rich solders can be raised or lowered by increasing or decreasing (respectively) the aluminum and copper contents (5 to 10 per cent). Attention is called to the fact that the aluminum contents of the soft light metal solders should not be raised above 10 per cent at the most, since this would raise the liquidus point of these solders to such an extent that the characteristic chief advantages of the soft solders over the brazing and welding alloys, i.e. their low temperatures of application, would be lost. This applies particularly to the range of the tin-rich alloys, although it is of considerable importance only in connection with the zinc-rich alloys containing up to about 50 to 60 per cent of zinc.

Soldering Technique

The mode of application depends to a large extent on the type and size of the castings repaired. Cleaning of the faulty sections and suitable cutting out of the faults themselves (if these consist of oxide or dross inclusions, etc., piping, cracks, etc.) should be effected with the care necessarily applied in welding and brazing. Swallow tail cuts yield better adhesion than ordinary V's, while if swallow tail cutting is impossible for local reasons, a certain amount of suitable undercutting should be attempted in order to improve the anchorage as much as possible. Pre-heating in stoves is unnecessary, of course, since the temperatures involved do not exceed 750° F. It is advisable, however, to pre-heat the near surroundings of the soldered section of large castings by means of the soldering torch.

The soft solder should not be poured into the recesses or cuts prepared for this purpose, as this would never ensure safe degrees of adhesion. Attention must always be paid to the fact that aluminium and light metal surfaces are bound to cover themselves with an oxide film at once, even if these are far too thin to be observed with the eyes. This is particularly true of preheated sections. In view of the fact that these films are exceedingly dense and adherent, they would not be removed by any soft solder poured on to or over them. It is always necessary for this purpose to "tin" the surfaces, which is effected by rubbing some of the solder over and into the surfaces by means of suitable wire brushes until the soldermetal film applied exhibits a brightly metallic, continuous mirror. This process destroys the oxide films previously formed on the light metal surfaces and ensures close metallic contact of the solder. The remaining operation is easy. The metal may be applied by any method desired. Deep holes are simply filled by pouring the metal into it, although, as stated previously, it should never be heated to complete fusion, which is not necessary for the purposes involved if soldering is effected correctly. Every solder alloy has its minimum and maximum temperatures, the zinc-rich alloys being in a more viscous state than the tin-rich alloys generally.

Considering everything, repair soldering is a much quicker and simpler operation than brazing or welding, and it can be carried out by practically anybody knowing the general outline of the process without having undergone a course of instruction or apprenticeship such as is required for brazing or welding. It is for this reason that repair soldering of light metal castings has maintained its position against the two other methods in spite of the technical disadvantages involved wherever the ultimate purposes of the castings do not require maximum mechanical or corrosive strength.

PLATING AND FINISHING
FABRICATION — ASSEMBLING
METALLURGICAL — ROLLING
CASTING AND JOINING

SHOP PROBLEMS

Preparing Sodium Gold Cyanide

Q. I would appreciate your sending me a practical method for preparing one ounce of sodium gold cyanide, containing 46% gold.

A. Theoretically, 1 ounce of sodium gold cyanide should contain 72.4% gold according to the formula $NaAu(CN)_2$. For such a small amount of salt, the most convenient method of preparation is the electrolytic one.

Exactly 0.5 oz. of sodium cyanide is dissolved in about 1 quart of water and the solution warmed to about 120°-150° F. A piece of 24K. gold is used as the anode and is weighed at intervals until exactly 0.46 oz. of gold are dissolved. Note that the weights given are avoirdupois in all cases.

The cathode is a small porous pot containing a 10% solution of sodium chloride and a piece of brass or copper as the electrode. A voltage of 2.6 volts may be used.

When the correct amount of gold has been dissolved, the cyanide solution is evaporated slowly to dryness preferably on a steam or water bath. The dry salt will have the following composition:

Sodium gold cyanide	63.6%
Caustic soda	9.2%
Sodium cyanide plus sodium carbonate	27.2%
Metallic gold	46.0%

—G.B.H., Jr.

Testing Strength of Electrodeposits

Q. Can you give me information as to the process used in determining the tensile strength of deposited copper. Also, what solution is best for use in separating a copper deposit from copper when making a female.

A. There is no standard procedure for testing the tensile strength of electrodeposited copper. In the case of heavy deposits of the order of those used in electrotyping work, a strip can be cut out and tested in a tensile strength machine. Dr. Blum of the Bureau of Standards has made tests of this sort.

The main difficulty in taking the strength of thin sheet is that they often break in the grips of the machine. Many samples should, therefore, be taken, and only those tests counted where the break occurs outside of the grips.

In the case of very thin electrodeposits, the tensile strength results would not be reliable, as even slight irregularities in the deposit would be of the same magnitude as the sheet, and cause unduly large effects. For testing of thin sheets, a Scott machine can be used.

Separating films of copper from copper can be done by treating with sulphide or dichromate solutions. Waxing with a thin mixture of carnauba and beeswax is good. Use turpentine for a thinner. Apply light films and wipe off excess well.

Separating nickel from nickel is generally less troublesome. Deposit a thin nickel on the original, treat this with a dilute (¼ oz./gal.) solution of potassium or sodium dichromate and apply a light nickel flash and then go into the build up copper.—G.B.H., Jr.

Rusting of Safety Pins

Q. We are sending you samples of safety pins that have rusted in a few weeks of storage. We cannot understand how they can have too light a plate, inasmuch as they are plated 45 minutes.

We are using prepared salts for making the plating bath.

A. In spite of the 45 minute plating time, the pins have a very thin coating of nickel.

The amount of nickel deposited will be dependent on the amount of current (amperage) going to the plating barrel. The amperage drawn by the barrel will depend on the condition of the solution, the anodes, and other factors such as size of load, condition of plating barrel and the generator. It is suggested you first have the solution checked for its chemical composition. It is sometimes difficult to maintain a solution in proper condition by the use of prepared salts due to the fact that some one constituent (such as a chloride) may be required in greater amount than is supplied by the prepared salt. To check on this get in touch with the manufacturers of your nickel salts.

An ammeter should be placed in the line going to the plating barrel so that the best current for the work in hand can be known. It is believed you are not using enough current.

It is also important to have the work chemically clean. A very slight film of oil or dirt will cause the nickel to deposit non-uniformly. The dirt will also delay the deposition of nickel. Examine the work for water-breaks after cleaning.

A simple qualitative test for the porosity of nickel on steel work is to dip the plated work in a solution of copper sulphate (about 2 ozs. of copper sulphate in a quart of water). A sample of the work can be taken from the barrel and dipped in this solution. If it turns red (showing copper) it means that the nickel is so thin that the steel underneath is exposed. This is shown on the enclosed pin, which was dipped in copper sulphate solution. The ends of this pin have sufficient nickel (due to the fact that the ends receive more current in the plating solution). This is only a rough test. It has been found that the thickness of nickel on safety pins should be about 0.00006" for normal rust resistance.—G.B.H., Jr.

In Appreciation of Ernest Lamoureux

By Fred A. Herr

Los Angeles, Cal.

The career of a man who has been intimately associated with the American electroplating industry for more than half a century, some 25 years of which were spent in plant work as laborer, foreman and superintendent of plating rooms, contains much of interest and value to everyone in the industry, veteran and novice alike.

Such is the career of Ernest Lamoureux, known affectionately as "Ernie" to all in the trade, who now is living in retirement in Los Angeles.

To listen to Mr. Lamoureux reminesce about his experiences is a pleasure all too few are privileged to enjoy. In the telling there unfolds, literally, the story of American electroplating during the past half century. In unfolding, too, the tale presents an absorbing insight into early technique, processes and developments, the evolution of methods and practices, and the gradual, sequential growth of the industry, interpolated with incidents and references that many men still active in various parts of the country will have little difficulty in recalling. There are names, also, of men who have heard the last roll call, and of others still living, the mere mention of which will revive memories of the Nineties and the opening decades of the twentieth century, which were, in Mr. Lamoureux's own phraseology, "the good old days."

The data for this biographical sketch were obtained in the course of an interview given the representative of METAL INDUSTRY in the living room of Mr. Lamoureux's palm-shaded bungalow at 207 South Reno St., Los Angeles. Mr. and Mrs. Lamoureux have lived in that city since 1936, coming from Chicago where they had continued to reside for seven years following his retirement from business in 1929.

Mr. Lamoureux was born in the village of Saint Angel, Quebec, some 15 miles from Montreal, as the second oldest son in a family of nine children. In 1879, the family moved to Cincinnati, and it was in the W. C. Davis Stove Co. in the Ohio metropolis of that day that Mr. Lamoureux, then nine years old, made his entrance into the plating industry. The father, as well as the two sons, obtained employment in the Davis plant. Young Lamoureux's job in the plating department consisted of wiring and unwiring the work before and after plating, there being no racks in those days. Later he was assigned to polishing and buffing on cast iron, such as hinge pins for stove doors, and other items. The plating department was under the supervision of an uncle, who had plated with batteries before the advent of dynamos.

"We used two of the early types of Weston dynamos," said Mr. Lamoureux, "and were also using rolled sheet nickel anodes. We had no rheostats or electrical instruments of any kind, and yet we turned out perfectly good work. All polishing wheels were of the leather covered type—flat, grooved, in fact, shaped to suit the various forms of work. The final polishing wheels were double covered, the second covering being attached with steel pins left in until the glue was thoroughly dried, then removed. The wheels then were trued up and smooth surfaced, leaving a leather face free of pegs. We also used some of

Ernest Lamoureux as he appears today.

these wheels for buffing nickel plated work where the design was flat. Our first cloth buffs were cut square, then turned, like one would a deck of cards, placed on the arbor, tightened, and worn down to a flat surface in turning out the work. The first new type of wheels were Sea Horse leather in full hides, cut in various diameters and shaped to suit the work in hand. Later on cloth and canvas wheels came into use."

According to Mr. Lamoureux, the first real advance in electroplating was the introduction of cast nickel anodes, which came into use during his period of service with the Davis Stove Co. in the early 1880's. Solutions in use at that time were all of the double nickel sulphate type, he declared.

In 1883, Mr. Lamoureux severed his connection with the Davis Co. and joined the Miller Plating Works' staff. He remained eight years, doing polishing, buffing and plating, and at the expiration of that period rejoined the staff of Davis Stove Co., which, meanwhile, had changed its name to Favorite Stove and Range Co. and had moved from Cincinnati to Piqua, Ohio.

Four years later (1885), he was offered, and accepted, a position as supervisor of the plating plant of the Sidney Holloware Co., at Sidney, Ohio. This, according to Mr. Lamoureux, marked the beginning of nickel plating of cast iron household hollow ware, the period predating the introduction of aluminum for household utensils.

In 1898, he transferred to the Columbus Bicycle Co., Columbus, Ohio, as foreman of the plating department. While this was in the early days of the bicycle industry, the firm, according to Mr. Lamoureux, had a production of 250 to 300 per day, and operated day and night shifts ranging from 200 to 250 men, depending upon seasonable demand.

Plating requirements shifted from the sublime to the ridiculous during his three-year service with the bicycle company. During the first year, he recalled, only the highest quality of plating work was demanded. During the second year, due to growing competition, restrictions were relaxed, and the company even went to the extreme of plating with duplex copper over 120 emery finish, a process which had been recommended by a supply concern.

"It caused nothing but grief," Mr. Lamoureux replied to the question of how that experiment had reacted. "We finally went back to 120 grease finish, and—in the third year—resumed real polishing and turned out the highest grade of work possible at that time."

New ideas and new methods in plating began to appear when Mr. Lamoureux went to work for the Phoenix Bicycle Co., at Freeport, Ill., in 1901. Slight changes in solutions were being made right along, he pointed out, and rheostats and ammeters, which had been used to a limited extent at Columbus, were employed on a wider scale in the Freeport plant. The latter was considered as having one of the most modernly equipped plating works of the time.

The Phoenix Co., in 1903, sold out to the American Bicycle Co., which was then in process of formation as the colossus of that industry. Refusing an offer as plating room supervisor of the Monarch Bicycle Co., Chicago, a subsidiary of the American Bicycle Co., Mr. Lamoureux took a position with the Dayton Fan and Motor Co., at Dayton, Ohio, in the summer of 1903. The firm manufactured various types of fans on which the finish had to match that of lighting fixtures and hardware in offices, restaurants and railroad cars.

"Here," said Mr. Lamoureux reflectively, "we solved a really bad spotting-out problem, the bugaboo of all platers, then as now. The fan blades of ceiling fans were mounted upon cast iron brackets with stems inserted into a cast iron spider with a dome effect at the bottom. These were

highly polished and brass plated. After much experimenting, we hit upon the idea of putting these parts into an oven at about 350° F., after plating, but before buffing. Our spotting-out difficulties disappeared entirely."

In recounting these experiences, Mr. Lamoureux chuckled softly and said he was reminded of a remark made several years ago by the late H. E. Wilmore to a group of friends to the effect that he did not believe that "Lamoureux had ever spent a day in his life in a plating room." The extent of Mr. Lamoureux's experiences in this respect will, therefore, come as somewhat of a surprise to many of his friends in the industry.

The fact that relatively good and durable work was achieved in the early days without the aid of modern methods, and that little rusting and corroding problems of serious consequence were experienced, may be accounted for in several ways, Mr. Lamoureux asserted.

"Unquestionably we had better castings," he said. "The quality of the polishing was infinitely better than that which prevails today. All work had to have a mirror finish, and the polishers had to wipe off every piece of work with lime to make it as free from grease as possible before delivering their work to the plating room. Hence, the cleaning problem was an easy one. The high character of the plating, although judged only by color and smoothness, was due to the time allowed. The latter two conditions made it possible to buff the work with 10- and 12-inch buffs with crocus, there being no lime solutions available then. Therefore, all of the nickel deposited, remained. None was ever cut through or off on edges or other places. Hence the amount of nickel actually deposited remained intact for protection of the base metal, whether iron or steel.

"All of this," Mr. Lamoureux emphasized, "may sound incredible, but it is nevertheless true. The first rheostat we used consisted of a loop of wire about two feet long, with a cross bar which could be moved up and down."

The second period of Mr. Lamoureux's career began in 1906. He had spent the previous 26 years in the plating rooms of various plants. He was to spend the next 23 years on the road, selling to platers the products of such firms as Zucker-Levett and Loeb, Munning-Loeb Co., Van Winkle-Munning Co., and Hanson-Van Winkle-Munning Co.

While he was still with the Dayton Fan and Motor Co. he received an offer to enter the selling field from Zucker-Levett and Loeb Co., of New York. He accepted and started with the firm in February, 1906, being assigned to a territory embracing Johnstown and Pittsburgh, Pa., and their contiguous areas, all of Ohio except Toledo, and parts of Indiana. Later that year he was transferred to Chicago, with the greater part of the middle-west as his territory.

When the Zucker-Levett and Loeb Co. was liquidated in 1908, Mr. Lamoureux operated as a freelance sales representative until 1911, when, with the founding of Munning-Loeb Co. in June of that year, he joined its sales staff. Mr. Lamoureux is proud of the record achieved by that firm, which within two years built up a volume of business sufficient to warrant the opening of a Chicago office and warehouse, and within another year quintupled its business and erected a Chicago branch factory. The name of the company was later changed to A. P. Munning and Co., and still later, through mergers, became the present Hanson-Van Winkle-Munning Co. To the firm's entry into the plating field, Mr. Lamoureux declared, can be traced many changes and developments in the industry, the beginning of scientific research, and the founding, by Mr. Munning of the Metal Finishers Equipment Association.

"The evolution from low purity nickel anodes to high purity had its origin in the New Jersey plant of Munning Co., said Mr. Lamoureux. "It came about through an order for a set of anodes on which was specified 97-98 per cent, and afterwards standardized as 96-97. This was the first commercial plating with such anodes and single nickel salts."

The Hanson-Van Winkle-Munning Co., according to Mr. Lamoureux, produced the special order to specifications, but was reluctant to engage in general manufacture of such anodes until their efficiency had been demonstrated. Mr. Lamoureux, as mid-west field man, pioneered their sale to the western trade.

"The issue of the success of such plates was quickly decided," he declared. "The subsequent history and progress is too well known throughout the industry to need further elaboration here."

It is his opinion that polishing in the plating industry has been a lost art for many years. He holds to the belief that a truly durable plate will never be achieved until such time as research in polishing is included in research of plating, with the object of restoring the art of polishing to its original standard. (Many other men in the industry share this opinion.—Ed.)

Mr. Lamoureux remained in the selling end of the business until 1929, when he retired. For seven years thereafter, he made his home in Chicago, but in 1936 moved with Mrs. Lamoureux to Los Angeles. Upon his retirement, the board of directors of the Hanson-Van Winkle-Munning Co. voted the following resolution and presented it to him in a handsome leather brochure, which remains one of his cherished possessions:

"For more than a quarter century Ernest Lamoureux has served the electroplating and polishing industry with vision, zeal and success, bringing to this corporation at its formation a wealth of experience.

He has loyally served the Hanson-Van Winkle-Munning Company and its predecessors during a development of the plating and polishing industry into one of the essentials of American manufacture.

It is with feelings of deep regret and sincere appreciation of his faithful services to them, that the officers, directors and stockholders of the Hanson-Van Winkle-Munning Company learn of his voluntary retirement from its active staff, and,

Resolve that this testimony of esteem be spread upon the minutes of its board of directors and that an engrossed copy thereof be sent to him.

Adopted

October 29, 1929.

A. P. Munning,
Chairman of the Board.
E. N. Boice, Secretary."

His activities in connection with the American Electroplaters' Society are succintly condensed in a biographical sketch which has been prepared by the officers of Los Angeles Branch for submission to the national committee at the 1940 convention.

The following outline of Mr. Lamoureux's career has been drawn and will be offered at the convention with the request that he be admitted to honorary life membership in the A.E.S.:

"We present for your consideration for Honorary Membership the name of ERNEST LAMOUREUX, and submit herewith a few pertinent records to support and justify our request:

He became a member of the original foundation branch of the Society in New York at its second meeting.

He was associated with the group that formed the Chicago Branch later.

He assisted in the formation of the Milwaukee Branch and subsequently organized St. Louis, Dayton and Grand Rapids branches.

His promotional work in the general interest of the advancement of the Society and its ideals, as well as its welfare, is too well known to require elaborating here.

He, with the late H. E. Wilmore and Oscar E. Servis, Past Supreme President, wrote the original Constitution of the Society.

He originated the Plan of Prize Awards for the best and most valuable paper in each year, and for exhibits by platers at the annual conventions. The plan was submitted to the Society during the administration of Mr. Walter Fraine, and he made the presentation of the first awards at the Montreal convention.

He was the first to advocate the commercial use of high purity anodes and single salt solutions in connection with which it was also shown that per-pound price of nickel in low purity anodes and double nickel salts was in reality higher than in high purity anodes and single nickel salts; also in this connection, and in the light of developments since, his paper in the Quarterly Review for December-January-February 1913-1914, and another in the June issue 1914 Review make interesting reading in that they prophesize developments of the Society and in the industry.

He was associate editor of the Review in 1914, and his editorial in the December 1914 Review might be read with appreciation of the foresight in the development in the Society itself.

He was untiring in his efforts in arranging and securing speakers for our annual educational sessions."

Post Scripts

The appearance of *Webb Knight* in top hat, white tie and tails at the Detroit banquet reminds us of the appearance of *Jim Brady* (No—not Diamond Jim) at the Washington, D. C. annual meeting of the A.E.S. some time ago. Brady had never been to a platers' banquet and dance before, and inquired of *Pimper*, now at the Bureau of Standards, what the customary dress was at these functions. He was informed equivocally that platers were very formal, and top hat and tails were required for entrance.

When most of the people were seated at the dinner tables, Brady made his entrance resplendent in shining top hat, white tie and tails and on observing that only the head waiter was dressed anywhere in togs resemblant of his, he thought he was in the wrong party until his pals led him to his seat.

Needless to say Mr. Brady felt conspicuous by his presence but a few invectives directed at his mis-advisors relieved his discomfiture somewhat.

•

Dave X. Clarin recently took a much needed vacation on a boat which our advisors tell us is his first real vacation since 1923.

•

Doug. MacDermid is another one of those plutocrats who can enjoy a Southern vacation. In a recent letter Doug. wrote: "This is a lonely spot (from a manufacturing viewpoint) and I wonder why there isn't a lot of industrial activity here so I could justify frequent visits."

Notes at Chicago

We want to congratulate the *Chicago Branch* of the A.E.S. for a most successful and enjoyable annual meeting. The thought of the educational committee in having lapel microphones insured easy hearing of the talks without extra effort on the part of the speakers. Dayton Branch please copy.

All of the talks were top-notch with the speakers being: *Harold Faint, Ernest Lyons, Jr., Dr. M. M. Beckwith* and *Austin B. Wilson.*

•

Frank Savage was there from Elkhart, Ind., but being a new papa, he had to hurry home without attending the banquet.

•

Phil Ritzenthaler, Henry Bornitzke, Bob Geissman and *Bob Steuernagel* were singing the praises of Milwaukee's meeting to be held on April 6. Phil seems to have borne the strain of recent fatherhood rather well.

Ernest G. Stenberg was sorry that the "boy wonder" president of Chicago University, Robert M. Hutchins, could see no learnin' in football and abandoned the sport or profession at Chicago U. Stenberg's boy was a star on the football team, and is also pretty good at baseball.

•

Reports are that *Bob Redmond* is quite an expert in cooking chicken dinners. In case any girls read this, Bob is a bachelor —need any more be said?

Two hotel detectives and the assistant manager couldn't stop *Jack Lockerbie, Ted. Eichstaedt* and *Alex Cardenas* from singing a bon voyage song at 3:00 A.M. to *Wilfred McKeon* on his departure to Mexico the next day or rather same day.

•

J. C. Jaegemann of Racine, Wisc., showed us some samples of anodically brightened stainless steel. The subject of electrolytic brightening or polishing has recently found a new lease of life.

Some people die from disease and others by accident, but here is one human being who would rather die of ski fever than old age. Clayton Hoff at Mt. Mansfield, Vt. (*Courtesy C. A. Vincent-Daviss*)

According to *Ernest Stenberg*, the first electrocleaning was done out Chicago way by *Fred Schulte*, about 1910. What say the rest of you readers?

•

Joe Nook from Kalamazoo looked as chipper as ever.

•

Oscar Servis had his proposed trip to Scandinavia spoiled by the European War. He and Mrs. Servis plan to attend the Los Angeles meeting in March and look up Sonja Henie for the Scandinavian atmosphere.

•

After the banquet and dance, night life centered: in the Udylite emporium with *Ed Berry* as Maitre d'What's Yours?; in the L'Hommedieu room with *Sam Cole* serving them as they called 'em; and in the Clinton room with *Rudy Hazucha* giving service with a smile.

I don't know who the fellow shown below is but he appears to be enjoying a recent lecture on finishing rather well —or isn't he?

One of the most humorous and harmless practical jokes is to engage two strangers in conversation and privately misinform each one that the other is very deaf and he will have to shout to make the other fellow hear.

However, when the participants in the stentorian conversation are prone to occasional extravagant delineations it should be a happy party indeed. The following drama has been based on information supplied by witnesses, although age may have colored the tale slightly.

Now I'll Tell One

A Drama in One Act and Two Scenes

Dramatis Personae:

Dick Crane, A Player of Practical Jokes
Niemo, A Guy from Oklahoma
Joe Downes, A Plater from Middletown

Time

(*Cleveland Convention of A.E.S.*—1936)

Scene One

(*Soda Fountain of Hotel Carter, Cleveland*)

Niemo: Howdy partner—what's all the hootin' and hollerin' hereabout?

Crane (who has just downed his third sarsaparilla): Why, it's the meeting of the American Electroplaters' Society.

Niemo: 'Lectroplatin', now you're talking down my alley, son. Out in Oklahoma way, we do some mighty large plating, the likes of which you Yankees have never seen. Take our oil well drills—they may be several thousand feet long and we have to plate them to prevent rust.—Mind passing the water, the soda dispenser made this last coke a trifle strong.

Crane: How can you clean them? You don't have tanks that long do you?

Niemo: Down our way we have some ripsnortin' sand storms and all we do is expose the work to the weather and in a few minutes the work is sand blasted clean as a whistle. Et cetera, et cetera.

After hearing of the wonders of plating in Oklahoma for some time, Dick decides he has to catch a train or something.

Crane: We have a fellow in Connecticut whom you ought to meet. He does some fancy plating but the only trouble with him is that he is hard of hearing and you will have to shout when you talk to him.

Scene II

Lobby of Carter Hotel

(Sundry crowd of Platers, Chemists and Travellers)

Enter *Dick Crane* and *Niemo*.

Crane: Has anyone seen Joe Downes?

Voice: There he is in the corner telling Bill Scott about his black nickel that is so black that a piece of charcoal will leave a white mark when rubbed across it.

Crane (aside to Downes): I have a fellow here who wants to hear about some of the big plating jobs that we do in Connecticut. He can't hear very well and you will have to shout rather loud when you talk to him.

The two lambs are led together and start a shouting conversation that brings the hotel cops to the scene thinking there's a fight going on. They find its only Niemo and Joe telling about the wonders of plating in their respective states. Niemo leads with a story about using a tunnel through the mountains as a plating tank by closing both ends and filling the tunnel with plating solution.

Downes: Maybe you have never heard tell about our Naugatuck River. They dump so much plating solution in it that no fish can live in it but it's still of some use to the plating shops on the lower part. Near Derby, they use the water for bright dipping and save buying acid. Some time ago, two youngsters went swimming in it and came out copper plated.

We really have something, however, when it comes to a deep plating tank. (By this time Joe's voice has started to weaken).

Niemo (Becoming impressed with the wonders of Connecticut plating): What sort of tank is it?

Downes: It's a chromium plating tank and it's so deep that any time we drop work into it we have to hire a diver to recover it.

Niemo (retires muttering): I'd tell that guy some real stories if he weren't so deaf.

Downes (aside): Not a bad guy if he wasn't so deaf. I wish he would buy an ear trumpet.

Say Dick—What the Sam Hill are you all laughing about?

Finis

Jack Gormley of A. C. Gilbert Co. and Al Rosenthal of Underwood-Elliott-Fisher Co. must be watching something unusually interesting.

Brown arrived home in a bad temper. "Hang it, dinner not ready *yet?*" he said to his wife, "I'm going out to a restaurant."

"Can't you wait ten minutes?" asked his wife.

"Will it be ready then?"

"No, but I'll be ready to go with you."

•

Earl Coffin, Chairman Program Committee of Los Angeles Branch's March 30 Educational Session, was outlining to fellow members his difficulties in trying to borrow what he described as a "South Seas" cut for use on the cover of the printed program. To have one made, it seems, would run into considerable money. So Coffin had been trying to borrow one from some steamship company which features "South Seas" advertising circulars.

The Los Angeles office of Matson, Dollar Lines and other ship companies were visited without result. All their advertising, Coffin was told, is handled in New York or San Francisco.

"Will it be so expensive to have one of our own made?" asked *Herold Kroeschke*.

It appeared that it would, according to Coffin, for the services of an artist would be required to draw the design.

"You mean something like this?" *Bruno Schindler* interrupted, casually handing Coffin a rough pencil sketch which he had been outlining during the conversation.

"Precisely," exclaimed Coffin. "That's what we want, almost to a T, except that you ought to slip in a couple of native girls lolling on the beach."

"What beach?" demanded *E. R. Holman*.

"Never mind," said Coffin. "A guy who can draw mountains and palm trees won't be stumped by a beach."

Schindler's sketch showed the serrated ridge of a mountain range, presumably in Hawaii, with palm trees swaying in the foreground. There was no beach for native girls to loll upon, but Bruno promised to provide one if Coffin decided to use his sketch.

So, if Earl finds it impossible to borrow, steal or highjack a halftone, don't be surprised if Bruno Schindler's art work with native girl's dutifully lolling, adorns the front page of the Educational Session program. The boys are already calling Bruno the Howard Chandler Christie of Los Angeles.

•

At the February meeting of Los Angeles Chapter, Secretary *Ray Bray* was reading a letter from National Second-Vice-president *Joe L. Downes* in which Mr. Downes urged the Chapter to have as fine an exhibit at the Dayton national convention in June as it had at the 1939 convention.

"Huh!" chuckled Solivan. "Our 1939 exhibit won't be hard to equal. We didn't have any."

•

Congratulations to: *Leon R. Westbrook* for his promotion to Research Manager of the Electroplating Division of the Du-pont Company; to *L. A. Critchfield* for his election pro tem to the presidency of the newly-formed Lancaster Branch of the A.E.S., and to *Jim Cosgrove*, a hard worker and a good fellow for his appointment to be Chief Chemist of the Standard Steel Spring Co., Corapolis, Pa.

Walter R. Meyer

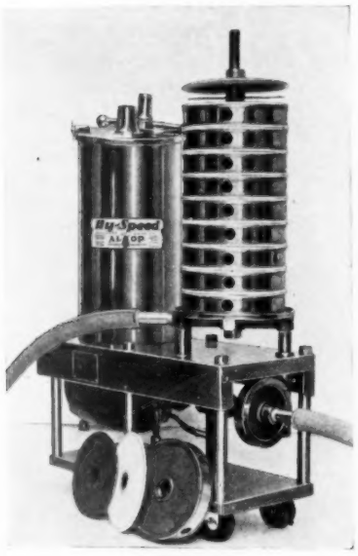
NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

New Type Filters for Plating Baths

A new type of filter for the filtration of electroplating solutions without the use of filter aids, has been developed by the Alsop Engineering Corp., Milldale, Conn.

These filters are said to be of simple construction and can be taken apart, thoroughly cleaned and reassembled in five minutes. The filter assembly is held in place by a single wing nut and is absolutely leak-proof. Due to its unique construction, the manufacturer states that each component part of the assembly may be thoroughly washed, thus making it easy to change from filtering one type of solution to another. Any degree of filtration may be obtained by filter sheets composed of fibrous material, molded in the form of a disc, available in several different standards of density or porosity. They are said to be economical and may be discarded at the termination of each run.



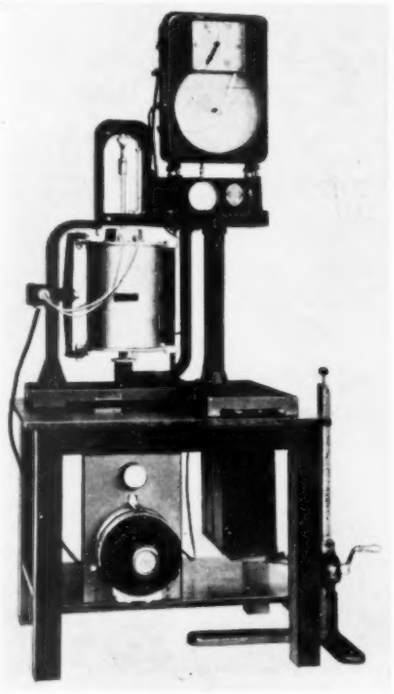
Filter unit using molded fibrous discs.

Standard models are constructed of stainless steel, iron, bronze, nickel and Monel metal, and operate with a capacity of from 5 to 30 gallons per minute, and under normal conditions are claimed to deliver 70% of their normal capacity, even after an 8-hour run.

The standard models are very compact, requiring approximately 9″ for width and less than 2′ for length and height. They are mounted on ball bearing, rubber-covered wheels and their compactness, portability and light weight render them readily available to filter plating solutions in any part of the plant.

New Dilatometer

A new dilatometer, designed by Stanley P. Rockwell of Hartford, Connecticut, is now available through The Bristol Company, Waterbury, Conn.



Direct reading dilatometer.

The Rockwell-Bristol Dilatometer, Model RB, is a direct reading dilatometer which both indicates and makes an ink record of time-dilation and temperature-dilation changes simultaneously, during heating and cooling cycles of ferrous and non-ferrous metals, ceramics and many other materials of rigid form.

Temperatures are recorded on a Bristol's Pyromaster Potentiometer, 12-in. round chart and the time element is recorded by a separate pen through a Telechron clock.

Further information may be obtained from Bulletin No. 546.

New Buffing Lathe

A new buffing lathe, Type MO, designed for a range of work not requiring a heavy duty machine has been developed by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies.

As shown in the illustration, a generous overhang for clearance is furnished. The body of the lathe is a heavy one-piece iron casting and the base dimensions of all sizes are 24″ wide by 20″ deep.

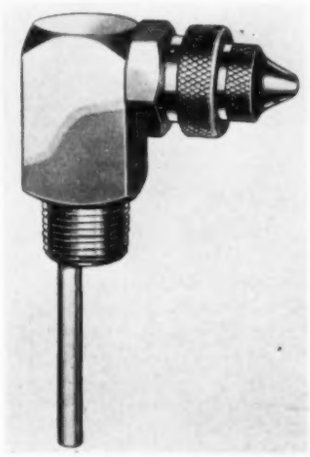
Drive is by "V" belt, with quick belt changing a special feature. Any one spindle speed from 1800 to 3600 R.P.M. can be obtained and other speeds can be had by changing the motor sheave pulley. The spindle is of 1¼″ to 1¾″ alloy steel.

New buffing lathe with large overhang.

Type MO lathe is furnished for 220, 440, and 550 volts, 2 or 3 phase, 60 cycle, A.C. power circuit; also for special or other A.C. or D.C. circuits.

Pneumatic Atomizing Nozzle

A pneumatic atomizing nozzle, as illustrated, has just been placed on the market by Spraying Systems Co., 4021 W. Lake St., Chicago, Ill. This nozzle is available with internally mixed round or flat spray. It is screwed directly into a pipe where liquid is maintained at a constant level—this same pipe serves as air supply header. Standard stock construction is brass; other metals can be specified.



Pneumatic atomizing nozzle.

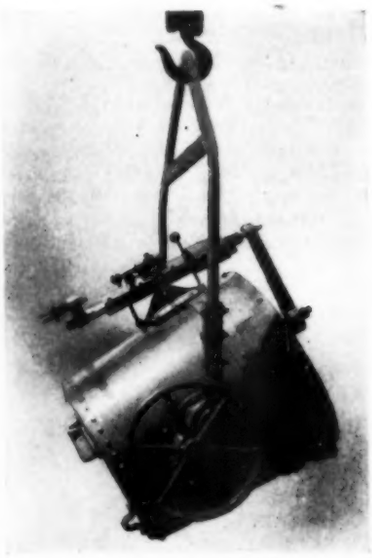
The nozzle is designed for chemical processes and humidifying in industrial processes where a constant proportion is to be maintained for intermittent spraying.

Worm-Geared Ladles

The Treadwell Construction Company, 648 South Twelfth St., Midland, Pa., has recently introduced a line of worm-geared ladles, ranging in capacities from two to five tons, for efficient handling of molten steel and other metals. Salient construction features include a stopper rig for drawing pure, slag-free metal from bottom of ladle and a geared turning device so designed as to prevent any movement of the ladle due to weight of molten metal.

The stopper rig, or harness, consists of a carrier arm, slide, guide, and stopper rod. The latter extends down through the metal to bottom of ladle. It has a sleeve on it made of fire clay or heat resistant terra cotta with graphite plug on bottom. When plug is raised, the molten metal is discharged through bottom of ladle and the slag, which floats on top, is prevented from getting into the ingot mould or casting.

The turning mechanism, which is self-locking, consists of a worm wheel mounted on the ladle trunion and integral with the bail. This gear in turn meshes with a worm of sufficiently low pitch to prevent any movement of the ladle. The hand wheel is mounted on a cross shaft with suitable gear for operating the worm. Roller type bearings are used and the entire mechanism is mounted in an oil tight case so designed that all gears operate in an oil bath.



Worm geared ladle.

The illustration shows a four ton ladle suitable for handling molten steel. It is made of ⅜" steel plate, is four feet high and four feet in diameter. Similarly constructed ladles with less gear clearance are available for handling molten tin, babbit, lead, zinc, etc.

The manufacturer will gladly furnish complete information on request.

Handee Mounted Wheel Chart

An attractive 16" x 22" wall type mounted wheel chart is offered by the Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago, Ill. It shows, in actual size, all the standard sizes and shapes of mounted wheels that are available for tool and die rooms and other uses. The chart will be found especially helpful in checking shapes when ordering mounted wheels for special jobs.

The company offers small abrasive wheels mounted on steel mandrels and a special bonded wheel for long life grinding of welds, sharp corners or wherever a tough hard bond is needed.

The makers are willing to send a sample wheel and chart to any reader of METAL INDUSTRY free of charge, so you can make your own tests and substantiate their claims in your own plant.

Manufacturers' Literature

Air Filter. An illustrated 30-page booklet describing industrial dust problems, and the applications of filtered air to air conditioning, ventilation, drying operations, products finishing, etc. American Air Filter Co., Inc., Louisville, Ky.

Copper and Its Alloys. A 68-page catalog describing and illustrating products of brass, bronze, copper and nickel silver, made by Downs-Smith Brass & Copper Co., 304 E. 45th St., N. Y. City, Commercial dimensions of available stock are given. Numerous data tables for use in the selection of copper or its alloys are included.

Couplings. Catalog No. 443, containing 44 pages, describes Farrel "Gearflex" couplings, illustrating the details of design and construction. It gives the applications, ratings, dimensions and weights of the various types of flexible couplings manufactured by this company. The cover is black, and silver embossed. Farrel-Birmingham Co., Inc., Ansonia, Conn. Copies may be obtained by writing to the company at 344 Vulcan St., Buffalo. N. Y.

Dilatometer. A bulletin describing the new Rockwell-Bristol dilatometer has just been released by the Bristol Co., Waterbury, Conn. The publication gives in brief form some essential facts regarding this newly developed equipment. A sample chart with record is shown for reference. Data regarding various types of tests and for specimen or sample required, are also given.

Electric Heating. A booklet graphically depicting the use of electric heat for electroplating, heat treatment of aluminum, brazing, chemical handling, anodizing, cleaning, etc. Various heating elements available are also shown. GES-2377. General Electric Co., Schenectady, N. Y.

Face Shields. A folder of the Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa., describes a new design of face shield which features a moisture resistant fibre headgear and leather sweatband.

Filters. An illustrated 4-page folder of the Alsop Engineering Corp., Milldale, Conn., describes new types of filters developed for filtering plating solutions. "Hy-Speed" filter discs are used with claimed high filtration capacity with small sized filters.

"*Handbook of Building Maintenance*" is the title of a 64-page booklet of the Flexrock Co., 2301 Manning St., Philadelphia, Pa., giving suggestions for the maintenance of floors and walls of office and factory buildings. The booklet describes floor surfacing and wall surfacing materials, as well as tools for preparing the surface and applying the surfacing materials. Well illustrated.

Hull Cell. A folder describes the new Hull cell for determining the characteristics of electroplating solutions with wide ranges of current density. The equipment consists of a cell, complete with electrodes, a rheostat and ammeter. Kocour Co., 4724 S. Christiana Ave., Chicago, Ill.

Inhibited Acid. A folder entitled "Clorodine" describes an inhibited muriatic acid solution that removes rust and calcareous scale from iron and steel without harm to the metal. American Chemical Paint Co., Ambler, Pa.

Inhibited Acid. A folder on "Deoxylyte," describes an inhibited acid recommended for use in connection with pickling and

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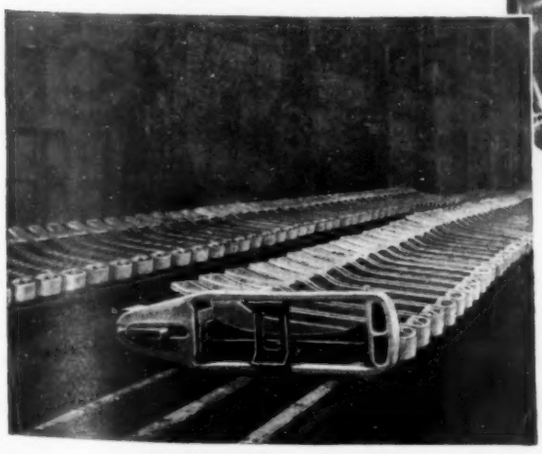
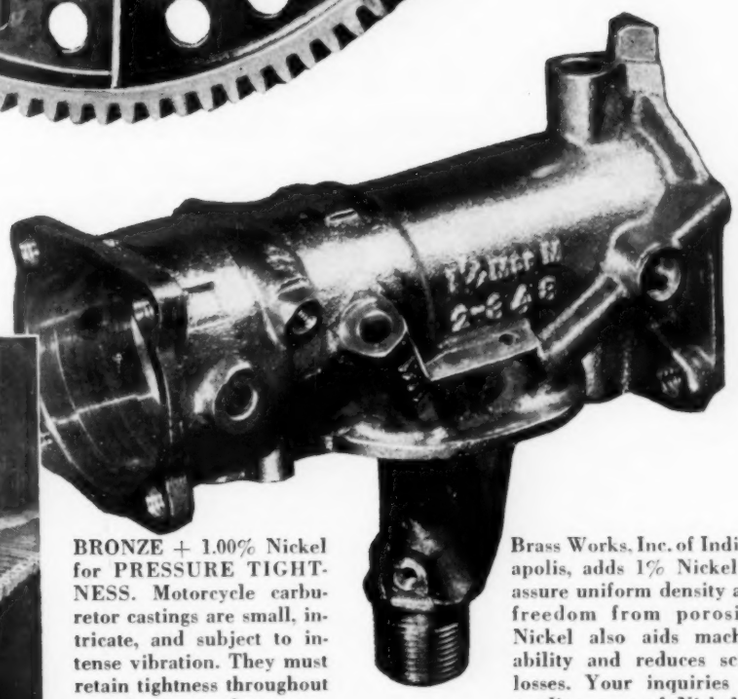
So little NICKEL makes these BIG IMPROVEMENTS

CAST IRON + 2.00% Nickel for INCREASED TOUGHNESS. 12-foot barking drum gears used in pulp and paper mills are subjected to wear and severe stresses. The Carthage Foundry & Machine Co., Carthage, N. Y., casts both gears and pinions from a Nickel alloyed iron of high machinable hardness and increased strength and toughness. With a 50% steel mixture the composition used for these gears is: T.C. 3.20%, Si 1.20%, Mn 0.90%, Ni 2.00%, and Cr 0.35%.

CAST STEEL + 1.25% Nickel for STRENGTH. Dead weight has long been a problem in the design of railroad rolling stock—particularly freight cars. To cut down excess weight and still secure sufficiently high strength and toughness to resist stresses to which freight car trucks are subjected in service, the Buckeye Steel Castings Co., Columbus, Ohio, cast these yokes, as well as side frames and bolsters, of a Nickel-manganese steel. Tests showed a tensile strength of 95,000 p.s.i. The composition is: C 0.28%, Mn 1.50%, Ni 1.25%, and Si 0.35%.





BRONZE + 1.00% Nickel for PRESSURE TIGHTNESS. Motorcycle carburetor castings are small, intricate, and subject to intense vibration. They must retain tightness throughout a wide range of temperatures. To the regular 85-5-5-5 bronze mixture Langenskamp, Wheeler Brass Works, Inc. of Indianapolis, adds 1% Nickel to assure uniform density and freedom from porosity. Nickel also aids machinability and reduces scrap losses. Your inquiries regarding uses of Nickel in irons, steels and non-ferrous alloys are always welcome.

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"4-A" Polishing Compounds Are Faster, More Efficient, More Economical for Polishing, Mirror Finishing of All Kinds of Steel, Including Stainless Steel and Other Alloys.

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Use it on any kind of a wheel, soft, hard, medium. Results will speak more eloquently than anything we could say.

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Instead of glue, use "4-A" Cement and Thinner, a uniform substitute for polishing Wheels, Belts, Buffs, Rolls, etc. Samples of Compound or Cement sent on request.

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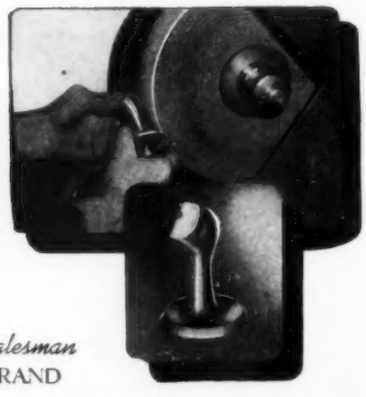
HAVERHILL, MASS.

FELT DOES IT BETTER

What a difference in your finished product when you use *Paramount Felt Polishing Wheels* for grease polishing—that all-important finish that swings the buyer's decision to your product.



Ask your supplies salesman for PARAMOUNT BRAND

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cleaning ferrous metals. American Chemical Paint Co., Ambler, Pa.

Motor Generator Sets. Bulletin 502 of the Reliance Electric & Engineering Co., Ivanhoe Rd., Cleveland, Ohio, describes motor generator sets of various sizes for producing direct current.

Powdered Steel. Charles Hardy, Inc., 415 Lexington Ave., New York, N. Y., have announced a powdered steel called "Sinterloy" for use in powder metallurgy. The powdered steel is available with carbon content of approximately 0.15%, 0.4% and 0.8%. Sinterloy may, in most cases, be pressed directly into the shape of the finished product so that machining cost and metal losses are claimed to be entirely eliminated.

Protected Metal. "It Peels Right Off" is the title of a folder of the American Nickeloid Co., Peru, Ill., which illustrates and gives a sample of pre-finished metal protected by paper. This paper is easily removed and keeps the highly polished surface free from marring or scratching during shipping or processing. Available in sheets or coils.

Tumbling Barrels. A 6-page bulletin of the Globe Machine and Stamping Co., 1200 W. 76th St., Cleveland, Ohio, describes and illustrates a new line of tumbling and burnishing barrels.

New Books

Lubricants and Lubrication. By James I. Clower. Published by McGraw-Hill Book Company, Inc., New York. Size 9¼" x 6¼"; 453 pages. Price $5.00.

This is a book which has been written for practical use to buyers, sellers and users of lubricants and for those who design and operate machinery.

A discussion of the source, production, refinement and theory of lubrication is given to better understand the use and care of lubricants.

Eleven chapters are devoted to the fundamentals of lubricants and lubrication and apply to all types of machinery and industry. Six chapters cover in detail the lubrication of steam turbines, steam engines, air compressors, refrigerating machines, and all types of internal combustion engines. The storing and handling of lubricants are considered in detail.

The book is well illustrated, particularly with drawings to illustrate the proper use of lubricants.

A valuable and comprehensive book.

Machine Shop Work. By Frederick W. Turner and Oscar E. Perrigo. Revised by Aldrick Bertrand, Tool Engineer, Cutler-Hammer, Inc., Milwaukee. Published by American Technical Society, Chicago, Ill. Size 6" x 8½"; 412 pages. Price $2.75.

This is the 5th edition of the popular book on Machine Shop Work, which has been thoroughly revised and brought up

to date. It is a practical and authentic book written in a clear style, covering approved shop methods including construction and use of tools and machines, the details of their efficient operation and a discussion of modern production methods.

The book is written in "How-to-do-it" style and problems attendant with the use of hand-operated and power-driven tools are described in detail.

A section is included on the use of the slide rule, which should enable the ready understanding of the use of the slide rule.

Recommended to every man who works in the machine shop.

Simple Methods of Analyzing Plating Solutions. Fifth Edition, 1940. This booklet was originally published in 1930 and has since that time, achieved a circulation of over 10,000 copies. The present edition has been revised and brought up to date by a number of changes in details and by the inclusion of methods of analysis of the H-VW-M semi-bright nickel (9-H) solution. Obtainable on request from Hanson-Van Winkle-Munning Co., Matawan, N. J.

Obituaries

Col. Arthur F. Townsend

Col. Arthur F. Townsend, chairman of the board of Raybestos-Manhattan, Inc., and general manager of the Manhattan Rubber Mfg. Div., Passaic, N. J., died January 14, at his residence in Ridgewood, N. J., at the age of 74.

Col. Townsend was a graduate of Massachusetts Institute of Technology, and started as shipping clerk with the N. Y. Belting & Packing Co., rising to assistant manager at Passaic. In 1893 he, with several others, organized the Manhattan Rubber Mfg. Co.

Milton M. Wagner

Milton M. Wagner, aged 77, died recently at his residence in Sidney, Ohio. Practically his entire business career had been with the interests of the Wagner Manufacturing Company. At the time of Mr. Wagner's death, he was president and treasurer of this company, and president and director of the Wagner Hotel Company.

He is survived by two sons, five grandchildren, a brother, and two sisters.

Associations and Societies

The Electrochemical Society, Inc.

The Spring meeting will be held at Wernersville, Pa., April 24 to 27. There will be scientific technical sessions on "Electric Steel" and "Progress on Electrodeposition," and a Young Men's Meeting on "Pure or Applied Physical Chemistry."

To You—

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Your FINISH Is What You Make It

The first plating rack of work immersed in a "still" tank of sparkling clean, clear water . . . like the first drink of a sparkling champagne . . . starts a solution. Repeated immersions of either, gradually builds-up solution strength to a point of contamination.

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As a contrast . . . the last plating rack of work passing through "VORTEXEDDY" Spray Rinse Tanks . . . at the close of the day . . . meets with the same sparkling clean, clear water as the first rack . . . There is no solution build-up . . . There is no contamination . . . A good FINISH is assured and secured.

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MacDermid Inc., Waterbury, Conn.
F. H. Bathke, St. Paul, Minn.

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Manufacturers of Welded Fabrications to Specification

American Electroplaters' Society

"Wing Your Way to Dayton"

Boston Branch

At the February 1st meeting, the Banquet Committee reported that the banquet will be held Saturday, April 13th, at the Statler Hotel, Boston, at 2 P.M. Tickets can be had from Secretary *A. W. Garrett* at $2.50 each.

William Cahill, president of the Providence Branch gave the members some advice on the proposed chemistry class, as he was the instructor of the last class. *A. Mintie* and *Colgate Gilbert* also spoke, and after this, *A. Mintie* addressed the meeting on "Hot Barrel Plating Solutions".

Bridgeport Branch

On Thursday, February 8th, the Branch held an old-timers' night, which was well attended by the members as well as visitors from Waterbury and New Haven.

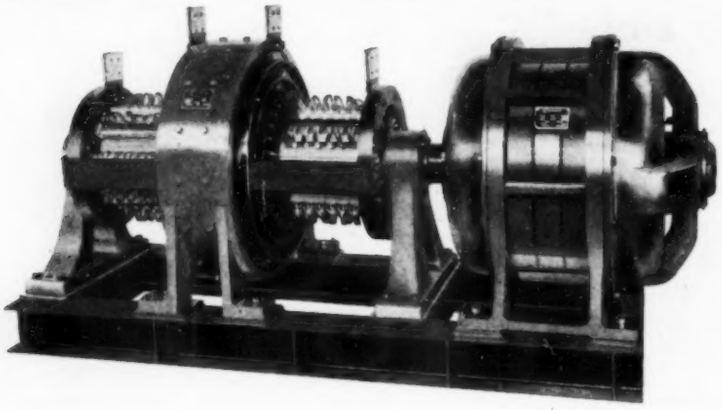
Refreshments, both fluid and solid, were served and moving pictures presented by *Earle Couch* and *Dr. Henry Kellner* of the Lea Mfg. Company, Waterbury, Conn., featured the meeting. They showed beautiful pictures, chiefly in color, of hunting trips made by *Ray O'Connor*, *Bob Leather*, *George Knecht* and *Earle Couch*.

The surprise of the evening was the presentation under the sponsorship of President *Wm. Ehrencrona*, of three educational movies.

Chicago Branch

The educational session and banquet held at the Palmer House, was the largest ever held with 350 in attendance at the educational meeting and 846 at the banquet.

J. W. Hanlon, president of the Branch,



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SULPHUR PRODUCTS CO., Greensburg, Pa.

Save your American Dollars to go to A.E.S. Convention—Dayton—June 10-11-12-13—John Feeley's doing it.

presided at the educational session and introduced president *Ray Goodsell*; secretary *W. J. R. Kennedy*; past president *Austin Wilson* and *Oscar Weickmann*, librarian of the branch and chairman of the meeting.

The Milwaukee Branch was well represented as was Detroit. *Dr. Walter R. Meyer* and *Palmer H. Langdon* of METAL INDUSTRY were present, as well as *Burt Daw* of St. Louis.

Charles Conley, president of the Dayton Branch invited all to attend the 1940 Annual Convention at Dayton.

Librarian *Oscar Weickmann* introduced the speakers, *Harold Faint* who read a paper written by *B. F. Bower* on "New Developments in Semi-Automatic Polishing and Buffing", *Ernest H. Lyons, Jr.*, who talked on "Cold Rolled Steel and the Electroplater", *Dr. M. M. Beckwith* on "General Shop Practice and Economics", and "An Illustrated Talk on Bumper and Anode Manufacture" by *Austin Wilson*. The lapel microphone was a decided improvement, as it enabled everyone to hear with ease, even the lowest voiced speakers.

The banquet, dance music and entertainment were of a very high calibre, and many complimentary remarks were passed to the Committee by those in attendance.

M. H. Longfield, Secretary-Treasurer.

Detroit Branch

H. LeRoy Beaver of the Abbott Ball Co., Hartford, Conn., addressed the meeting on March 1st, the subject of his talk being, "Methods of Barrel Finishing".

On April 5th *Dr. Wm. Blum* of the Bureau of Standards, Washington, D. C., will address the Branch, the subject of his talk to be announced.

Los Angeles Branch

Arrangements for accommodating an attendance of some 250 to 300 west coast and eastern electroplaters at the annual Educational Session of Los Angeles Branch at Hotel Roosevelt in Hollywood, March 30 have been completed by the arrangements committee headed by *D. M. Bedwell*.

Principal speaker will be *Dr. William Blum*, of the National Bureau of Standards, Washington, D. C., who is scheduled to deliver the opening address at the morning session and the closing talk at the afternoon session.

The complete program of speakers and their subjects, as arranged by the Program Committee consisting of *Ernest L. Lamoureux* and *E. R. Holman*, is as follows:

Morning Session, E. R. Holman, Chairman.

10 to 10.45 a.m. "A Summary of the Researches on Plating at the National Bureau of Standards, Washington, D. C.," by *Dr. Blum*.

10.45 to 12 N. "Bright Nickel Plating in Full Automatic Equipment," by *F. A. Maurer*, research chemist, General Electric Co., Ontario, Calif.

12 N. to 1 p.m Intermission for lunch.

Afternoon Session, E. R. Holman, Chairman.

1 to 1:15 p.m. "The Electrodeposition of Alloys," by *J. G. McCallum*, Chairman, Golden Gate Chapter, A.E.S., Berkeley, Calif.

1:35 to 2:45 p.m. "Principles of Detergency," by *Dr. T. K. Cleveland*, of the Philadelphia Quartz Co., San Francisco.

2:45 to 3:30 p.m. "Current Practice in Plating Alloy Die Castings," by *William Broughton*, of Morris Kirk & Sons Co., Los Angeles.

3:30 to 4:30 p.m. "Specifications For Electroplated Coatings," by *Dr. William Blum.*

7:30 p.m. Dinner-entertainment in Blossom Room of Hotel Roosevelt.

An entertainment program of Hawaiian music, singing and dancing, augmented by other special numbers, has been arranged for the dinner period. In keeping with the Hawaiian decorative scheme of the dining room, most of the entertainment will be Hawaiian in character. Leis and other favors will follow the same motif. Sales of tickets for the dinner started off briskly at the February meeting of the chapter at Hotel Rosslyn, where approximately 60 commitments for tickets were recorded by Secretary *Ray Solivan.*

Among former national officers of the A.E.S. who have arranged to attend is *Oscar E. Servis*, of Chicago, Past Supreme President, who is coming west by train with Mrs. Servis and two friends.

Pre-convention activity for early arrivals has been arranged along the following lines:

Wednesday, March 27: Special dinner and meeting of Los Angeles Chapter at Hotel Rosslyn. The dinner will begin at 6:30 p.m., with the ladies in attendance. Arrangements have been made for the ladies to attend a downtown theater during the business session, opening at 7:30 p.m., at which Dr. William Blum will address local and out-of-town members on "Methods of Testing Electroplated Coatings."

Thursday, March 28: Visit to General Electric Co. plant at Ontario, Calif. where *F. A. Maurer*, the company's research chemist, will serve as guide through the factory.

Friday, March 29: Trip to Naval Air Station, San Diego, with stop enroute at La Jolla to inspect tests being made there by American Society of Testing Materials.

Personnel of committees arranging the Educational Session is as follows: General Chairman, *D. M. Bedwell*; Educational Program: *Ernest L. Lamoureux* and *E. R. Holman*; Publicity, *M. D. Rynkofs, Bruno H. Schindler*; Music-Entertainment, *Earl Coffin, Ray Solivan*; Favors, *William A. Vensel, Herold J. Kroeschke*; Hotels, *M. D. Rynkofs* and *Ernest L. Lamoureux*; Prizes, *Bruno H. Schindler, C. E. Thornton, Herold J. Kroeschke, William A. Vensel, M. D. Rynkofs, Earl Coffin.* Printing, *Ray Solivan.*

Milwaukee Branch

The annual educational session and dinner dance will be held April 6th at the Schroeder Hotel.

The following papers will be presented: "Patents in the Plating Industry," by *Gustaf A. Soderberg*; "Some Overlooked Problems in Electroplating", by *George B. Hogaboom*; "Cost", by *A. J. Hermansen*, and a paper by *Walter J. Pinner*, not announced.

Newark Branch

Paul A. Oldam of E. Poeter & Co., Irvington, N. J., will be the guest speaker on March 15th, the subject of his talk being "The Effect of Base Metal Upon Color of Gold Electrodeposits".

New Haven Branch

At the February 6th meeting, *S. L. Lapata* of the Duriron Co., gave an interesting talk on "Practical Aspects of the External Heating and Filtration of Electroplating Solutions", which was profusely illustrated with fine slides.

The metallurgical class held on Tues-

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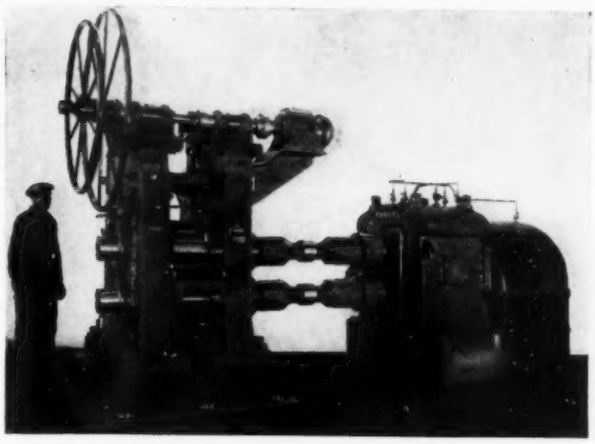
PERFORMS COMPLETE RANGE OF ROLLING OPERATIONS ON WIDE VARIETY OF METALS



This 16″ x 16″ two-high rolling mill is an example of Farrel engineering *to fit the job.* In this case the job was the rolling of a wide variety of metals, including copper, brass, bronze, silver, nickel silver, monel metal, bi-metals and semi-precious metals. Production requirements dictated a mill that could be used for all rolling operations from breaking-down to finishing, and one of heavy, rugged construction to handle large reductions.

The mill has forged, heat-treated, alloy steel rolls . . . . heavy Meehanite housings . . . . force-feed, grease-lubricated, plain, bronze bearings . . . . combination double-handwheel screwdown with motor drive for rapid approximate positioning of the top roll . . . . hydraulic top-roll counterbalance . . . . Meehanite delivery and feed tables . . . . adjustable side guides on feed table . . . . a wiper on each roll . . . . and a safety bar tripping device for quick stopping in an emergency.

The reduction gear drive and pinion stand are combined in an integral unit, with Farrel-Sykes continuous tooth herringbone gears and mill pinions mounted in anti-friction roller bearings. Gears and bearings are force-feed lubricated. A Farrel Gearflex Coupling connects the motor and drive and universal spindles connect the pinion stand with the mill.

Designing and building mills such as this to meet particular requirements is a specialty of Farrel-Birmingham. If you have a special mill problem our engineers will be glad to consult with you.

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• Wyandotte CSR Cleaner is giving most satisfactory results in many plants for cleaning steel stampings prior to plating with BRIGHT NICKEL. Let us tell you more about Wyandotte CSR Cleaner.

• Wyandotte Service Representatives are prepared to help you . . . not only with carbon smut removal, but also any other cleaning problems that may pop up. No job is too big, none is too small.

day evening, February 13th was a decided success, with *L. Theelin*, metallurgist of the Chase Brass & Copper Company, giving a lecture on "Tube Mill Practice".

A half-hour discussion devoted to shop problems followed, with *T. H. Chamberlain* conducting. *Bob Mooney's* description of "Triple Chrome Plating", featured.

On March 5th the speaker at the open meeting will be *H. A. Grove* of Republic Steel Corporation.

Joseph T. Sullivan, Librarian.

New York Branch

The February open meeting was addressed by *Thos. H. Chamberlain*, supervisor of Metal Finishing, Chase Brass & Copper Company, Waterbury, Conn., whose subject was "Finishing of Copper and Copper Alloys". The talk proved to be most enjoyable.

The second meeting of the month consisted of a Question Box Hour, conducted by *Dr. C. B. F. Young*, Librarian.

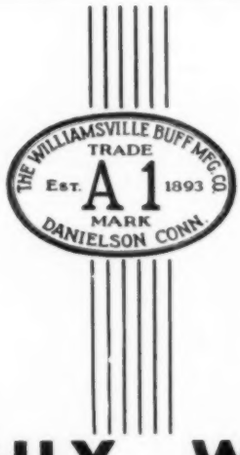
F. J. MacStoker, Secretary.

Personals

George M. Millspaugh, formerly with the Lacquer & Chemical Corporation of Brooklyn, N. Y. as sales representative, has now become associated with the Bias Buff & Wheel Company, Inc. of Jersey City, N. J., in the capacity of sales representative for part of Connecticut, Massachusetts and Rhode Island.

Mr. Millspaugh has had 10 years practical experience with the Seth Thomas Clock Company of Thomaston, Connecticut, where he was in charge of all metal finishing, buffing, plating, lacquering etc.

This broadened knowledge of the finishing field will prove of intense value to him in his new connection, especially in an advisory capacity among users of buffs and polishing materials.



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BUY WILLIAMSVILLE BUFFS

J. M. Cosgrove Joins Standard Steel Spring Co.

R. C. Enos, President, Standard Steel Spring Company, Coraopolis, Pa., announces the appointment of *J. M. Cosgrove* as Director of the Development Laboratory. Mr. Cosgrove will be actively interested in research on the new corrosion proof coating developed by the company.

J. M. Cosgrove

Mr. Cosgrove was formerly Chief Chemist of Noblitt-Sparks Industries, Inc., and before that, Process Control Engineer for the Meaker Company, and Development Engineer in charge of plated finishes for Western Electric Company.

Mr. Cosgrove graduated from the Massachusetts Institute of Technology as an electrochemical engineer. He also has a degree from Manhattan College. He has written a number of papers on cleaning and finishing problems in the coating of metals and is well known in this industry.

Colonel A. L. Mercer, President and *H. L. Trembicki*, Manager of the Metal Cleaning Department of the *Cowles Detergent Company* are pleased to announce the appointment of the *Eaton-Clark Company*, 1490 Franklin Street, Detroit, Michigan, as distributors of Cowles Anhydrous Metal Cleaners. The Eaton-Clark Company will maintain a complete stock of Cowles Cleaners in their Detroit warehouse and will ship to all points in Michigan. Mr. *F. H. Hitchcock*, Cowles salesman, will work closely with the Eaton-Clark organization and will render any service necessary.

Roger Sundmark, who for the past 12 years has been manager of Los Angeles branch of *Charles F. L'Hommedieu and Sons Co.*, of Chicago, plating and polishing equipment firm, has transferred to *Kelite Products, Inc.*, 909 East 60th St., Los Angeles, as manager of the plating supply division. Mr. Sundmark has established a splendid record in the equipment

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Give it a touch of glamour and beauty with one of these stripes, scorings, crimpings or corrugations. The change will actually bring you production savings. Completely *pre-finished*, American Bonded Metals can be drawn, stamped, formed or assembled into your completed product. Elimination of plating—either before or after fabrication—polishing or buffing brings substantial production savings. Write on your company letterhead for a new brochure showing the latest in *pre-finished* metals, designs, patterns and ideas.

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Five Sections of this Type "A" Buff has as much polishing surface as Ten Sections of an ordinary buff

In addition to the double polishing surface this buff will do at least 50 per cent more work, because of the bias principle at every point on the periphery which insures against the cloth fraying when brought in contact with the work.

Saving of compound is effected due to the overlap ply shown on the face. Try this Type "A" in your polishing department.

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1940 PLATING and FINISHING GUIDEBOOK

The 1940 Plating and Finishing Guidebook will be mailed April 30th to subscribers of Metal Industry. This edition has been completely revised and new sections have been added on plating and finishing. In addition, a section on organic finishing has been included.

end of the electroplating industry. He still has the looks of a college senior, and strangers find it difficult to balance his youthful appearance against a background of more than a dozen years in executive positions.

Frank T. Sisco, Editor, Alloys of Iron Research of the Engineering Foundation, New York City, has been elected Chairman of the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers for 1940, according to an announcement made today by J. Hunter Nead, Chief Metallurgist of the Inland Steel Company, the present Chairman. Mr. Sisco took office following the annual meeting of the A.I.M.E. in February.

E. L. Newhouse, president of the Federated Metals Division of the American Smelting and Refining Company, announces the appointment of *Saunders Jones* as sales manager of the company's Whiting, Indiana branch.

Mr. Jones brings to his new position 12 years of experience as a prominent executive in the automotive field. He was formerly vice president and general sales manager of The White Motor Company, at Cleveland, and more recently vice president of White's eastern region, with headquarters at New York City.

In his new position, Mr. Jones will direct the sales of the Federated Metals Division of the American Smelting and Refining Company throughout the Chicago District, with headquarters at Whiting. Mr. Jones will make his home at 1448 Lake Shore Drive, Chicago. He is unmarried, a native of Atlanta, Ga., and a graduate of the University of Georgia.

Davies Heads Pennsalt Market Research

Well known throughout the steel and chemical fields, *Richard L. Davies* has been appointed manager of the newly established Market Research Department of the Pennsylvania Salt Manufacturing Company, according to an announcement by *Leonard T. Beale*, President.

Mr. Davies is known to many in the chemical and allied industries through his sales development work on various chemicals, as well as through his chemical manufacturing and usage patents, and for his contributions to trade and technical publications.

The new department is organized to make studies of the market for products now manufactured by the company, or products under contemplation; to launch the sale of new products in line with sales and management policies, and to suggest to the management what should be considered for future production and sale both in the heavy chemical and specialty departments.

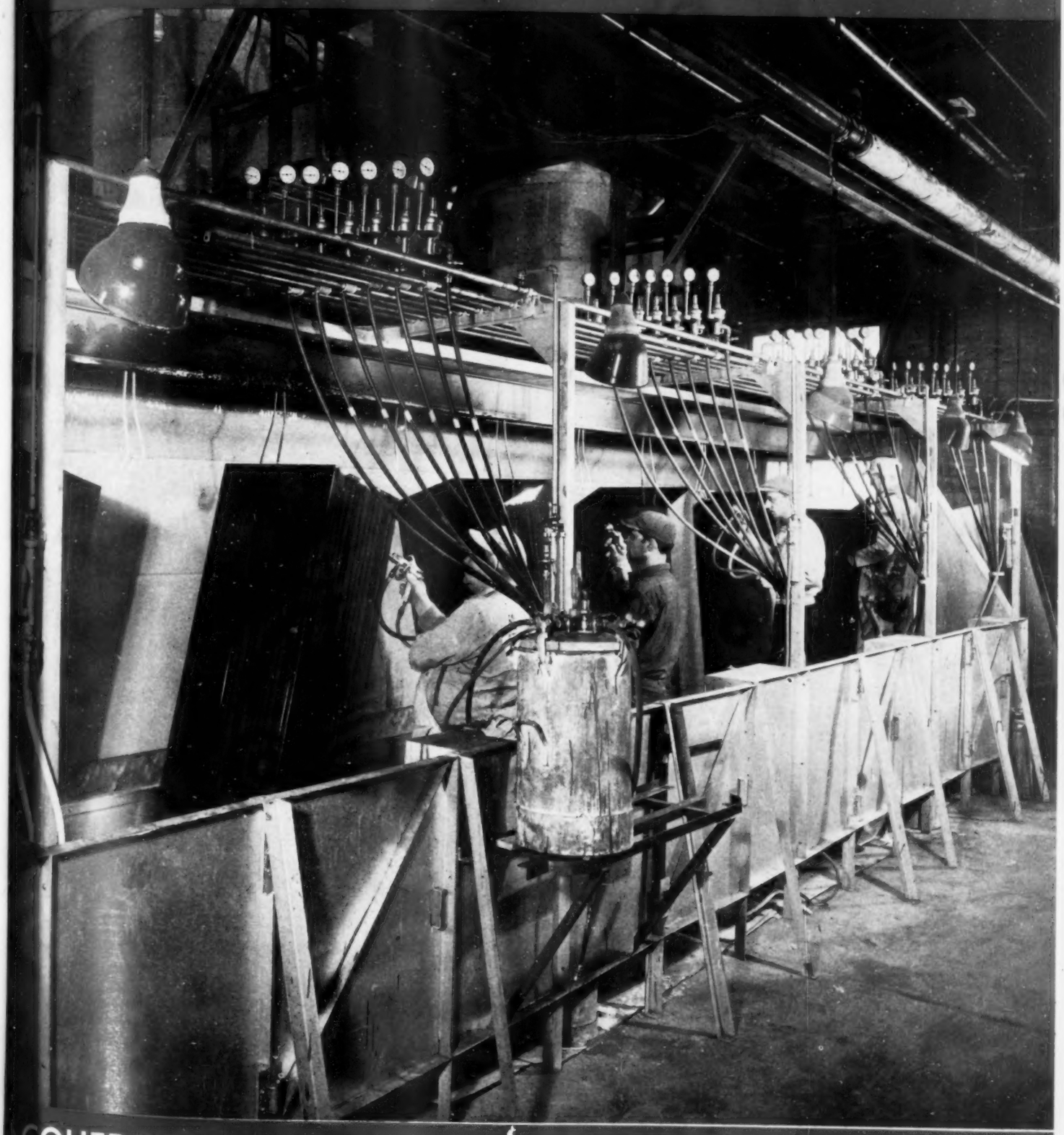
Market trends and opportunities will likewise be presented to the management for formulation of production and sales policies.

Mr. Davies' headquarters will be at the Executive Offices of the company in Philadelphia.

MARCH, 1940

ORGANIC FINISHING

SECTION OF METAL INDUSTRY



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Usually in this space we describe some particular Zapon finish. This time we tell of the service of numbers. Numbers are constantly assigned to formulas being developed and tested in our laboratory. Some are abandoned, some are held for other uses or further work. To give a name to every one of the actual numbers of formulas would be manifestly impossible.

When one of these formulas proves out and wins acceptance by our customers, it gets out of the laboratory stage and assumes a real identity.

To us at Zapon these numbers—at first cold and impersonal—become alive and full of character. We have developed a material that gives certain desired results in finishing a line of products. It has its number for identification. It has run the gauntlet of laboratory tests, which represent tireless research to produce the finish you need.

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Then and only then does the number become alive to you. It is significant that so many users of Zapon finishes know and specify the number or numbers which they recognize as identifying just the material they must have.

We of Zapon are ready to help one of these numbers work for you.

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ORGANIC FINISHING

SECTION OF METAL INDUSTRY
MARCH, 1940

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Organic Finishing— A Major Industry

It is sometimes questionable if the magnitude of the organic finishing industry in the United States is fully appreciated. During the past year the Bureau of Census reported the industrial sales of organic finishing materials of 580 establishments to be over 125 million dollars. Trade sales for the same group in this period were more than 200 million dollars and total sales, including unclassified items of 100 establishments, approached a value of 400 million dollars. Although this is a considerable sum it is only part of that involved in the whole procedure of organic finishing from the production of raw materials through the application of the final product. Labor, equipment, research, advertising, merchandising—the amount of money for these is tremendous.

How is this great industry supported? Wherever protection or decoration can be supplied by an organic finish there is an answer to this question. In a recent listing which came to our attention, nearly a hundred separate and distinct applications were given for a single type of organic finishing material. We are all familiar with the use of finishing materials on automobiles, furniture, appliances and industrial equipment. There are, however, a large number of lesser known uses. Toys, pencils, shoes, fishing rods and lines, thermometers, straw hats and wire cable are a few examples. Taken together, the many and various lines of manufacture in which lacquers, enamels, japans, etc., are employed mean the consumption of large volumes of finishing materials.

The rate at which organic finishing materials are being extended to new fields indicates an expansion which will continue for many years. If the business is a large one today, there is every reason to expect it to be larger in the future.

L. J. LANGDON, *Publisher* • THOMAS A. TRUMBOUR, *Business Manager* • DR. WALTER R. MEYER, *Editor*

Paint Color Control

By E. A. Zahn

Works Laboratory
General Electric Co.,
Schenectady, N. Y.

The author describes his experiences with color aging and color control of organic finishing materials by the use of the spectrophotometer. The construction of this instrument was described by D. K. Donovan in the October issue of the Organic Finishing Section of Metal Industry.

"Color" has been the subject of discussion for many experts in its relation to industry and the home. The meaning of "color" has been described in technical terms and in plain language by various technicians, and its importance to the world has been pointed out with great emphasis. Control of color is a problem which has received a great deal of attention, and in many cases, some satisfactory control method has been found. But there are still color control problems which are in need of serious consideration.

In the paint industry, there is a need for a great amount of research work on color control which is yet in its infancy. Many in industry have at some time been confronted with color problems, and the majority of these have been connected with organic finishing.

The human world has become color minded in the past few years. That half of the human world which had no great interest in color has had it forced upon them by the other half. Copying color and color schemes can be a business or a profession. What is necessary to make it so is that some definite control methods be put into effect to illuminate our path of progress in color control beyond previous practice methods.

In discussing color control of organic finishes in this paper, the writer has attempted to divide the subject into separate problems so that home and industrial paint color problems can be handled separately.

With the aid of the General Electric recording color analyzer, the "Spectrophotometer", every paint color or discoloration question can be answered. Through the eyes of this instrument, we can see a charted picture, numerically described and in great detail, of what our eyes can see but cannot record. Every pair of eyes varies from any other pair through a range that goes from color blindness to almost unbelievable eye efficiency. Although the very best pair of human eyes are unable to distinguish minor differences existing in two different places, they are usually able to detect these differences by comparing with a standard. The problem which is then given to the color analyzer is the recording of these differences in a readable form.

It is agreed that white is not to be considered as a color, but as a substance. Nevertheless in the manufacture of white finished commodities, we are confronted with our greatest color problems. Up to this time, there is no usable white finishing material which can be considered 100 per cent white, or as white as a block of pure magnesium oxide which is standard for use in making measurements of white substances or finishes. The pigments used in white finishing materials are closer to 100 per cent white than the vehicle in which they are dispersed. Therefore, we can henceforth consider all white paints as colors until a perfect colorless vehicle can be produced.

The average white refrigerator enamel has a reflecting power below eighty per cent in comparison with magnesium oxide's 100 per cent. To produce a pleasing white color when baking temperature and color life are of primary importance, it is necessary to employ tinting materials which will hide distasteful baking discoloration and also act as stabilizers during exposure of the white finish to light while in use. To entrust the delicacy of this valuable procedure to the human eye, seems somewhat out of date when an instrument can record within one per cent of the true color. Even if the eye could detect a one per cent difference, it would be difficult to say whether it was lighter or darker, much less detect the predominating color which caused it to appear lighter or darker.

Fig. 1 shows a color curve of an ordinary white refrigerator enamel after baking. The greater portion of this curve shows a reflection value averaging well over eighty per cent. Its shape is representative of the average baked white enamel and also indicates that some tinting materials have been added.

If Fig. 1 represents a standard from which to work in connection with an accurate reproduction of the color, it also represents a standard which will not and cannot discolor, no matter where or for how long it is stored. Fig. 2 represents the same color after the panel has been stored in the dark for fourteen days at 150°F. Note:

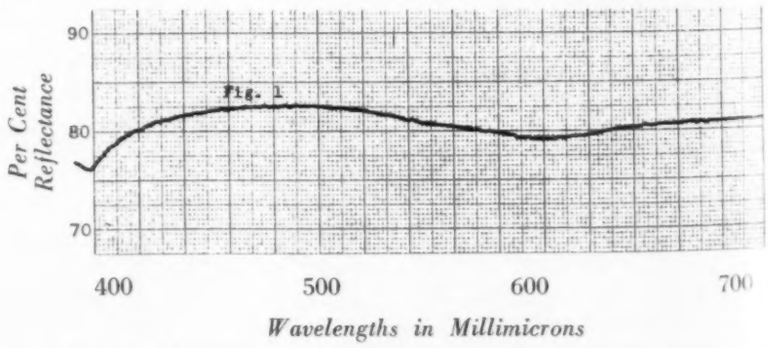

Fig. 1. Color curve of a white refrigerator enamel after baking.

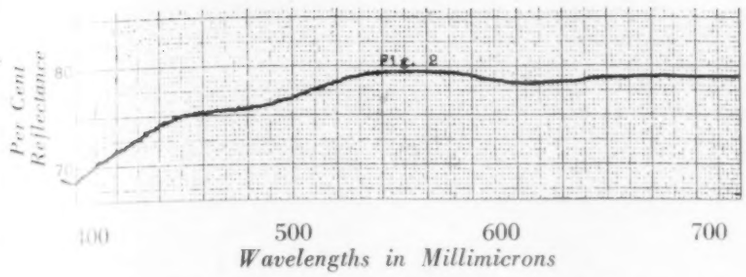

Fig. 2. Color curve of enamel in Fig. 1 after storing in dark for 14 days at 150° F.

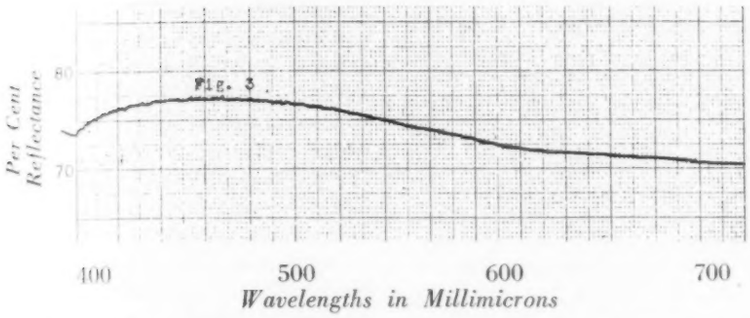

Fig. 3. Color curve of panel after 60 days' storage of liquid sample.

This color curve is made from the same panel as Fig. 1 curve, proving that the usual method of storing samples is not efficient. The entire curve has dropped below the eighty per cent line indicating that a considerable amount of darkening has been the result of this exposure. Also the general shape of the curve has changed proving that some opposite color is prominent. Since colors seldom increase in brightness, we can assume that this Fig. 2 curve shows a color loss in the blue and violet range, or a new color prominence in the yellow range. Actually the sample has not turned yellow, it has lost its reflecting value faster in the blue and violet range than in the other colors.

Assuming then, that the storage of dry standards is not a satisfactory way of maintaining a white color standard, let us view this same material that produced both of these curves, after it has been stored as a wet standard for sixty days. The curve shown in Fig. 3 is produced from a panel, prepared after sixty days storage at room temperature of the liquid sample.

During the sixty day storage period, the sample can was opened several times.

The curve shown in Fig. 3 shows a tendency to slope in the opposite direction from the dry storage sample (Fig. 2). Fig. 3 curve shows a decided loss of color in the yellow, orange, and red range, and it also shows that some of the reflection values of the other colors have been lost. It was later found that certain of the original tinting materials used caused a chemical reaction in the container, which in turn caused this great amount of discoloration of the wet sample.

Only a part of the problem of white color control is seen in the samples as shown in Figs. 1, 2, and 3. The baking temperature variations play havoc with these whites as is readily seen in Fig. 4. This curve was produced by using the same white material baked at a temperature 15°F higher than the temperature used originally.

Oven temperature control is always a problem when white baking materials are involved. In this Fig. 4 curve, we have a typical example and proof that a baking temperature difference of fifteen degrees higher on the particular material in question can have the same effect as discoloration from heated storage in the dark. A comparison of the curves shown in Fig. 2 and Fig. 4 will clearly show the similarity.

This white finish when applied to a household appliance, will discolor in time. The next problem then is to know beforehand exactly how much it is going to discolor in normal use over a given period of time. We also want to know if that discoloration will go beyond the point where a customer

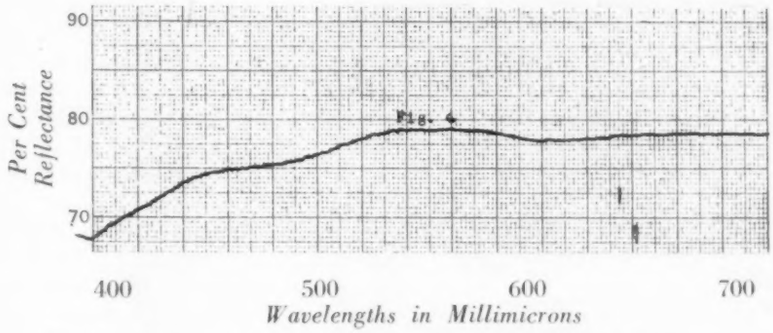

Fig. 4. Curve of enamel of Figure 1 baked at 15°F. higher temperature.

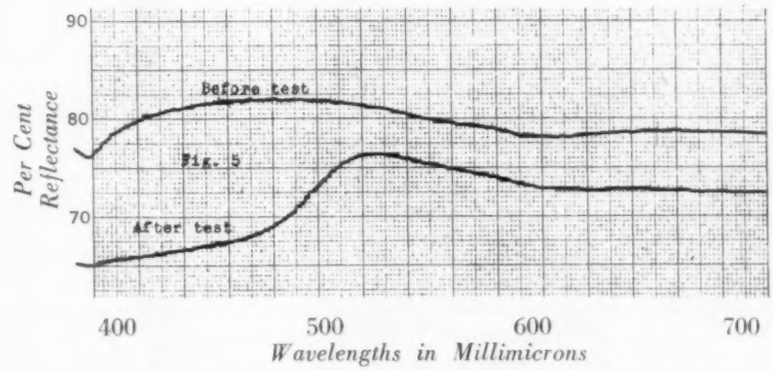

Fig. 5. Color curve of enamel of Fig. 1 after discoloring to represent one year service.

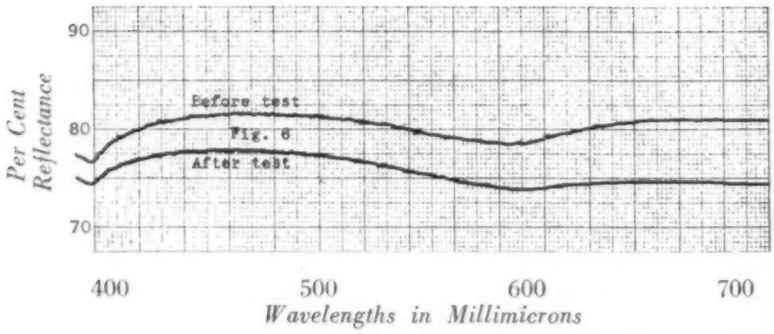

Fig. 6. Color curves of another enamel before and after aging.

would be likely to notice a change of color. By means of an accelerated test method, the panel from which the curve shown in Fig. 1 was made, was discolored to represent one year of actual service. The results are shown in Fig. 5.

By an established accelerated test method, the panel was discolored to represent the maximum color change that could possibly take place over a long period of time, under poor operating conditions. At one point the color loss is as much as fifteen per cent.

Fig. 6 shows a set of curves representing the discoloration of another popular type of white enamel after receiving the same treatment as the sample described in Fig. 5.

This material sample has been prepared for the purpose of demonstrating that with the aid of the color analyzer, the fugitive and non-fugitive tinting materials can be controlled in such a way as to make the eventual discoloration less noticeable to the eye. Note that the general shape of the after test curve in Fig. 6 is almost identical with the original curve before test.

The discoloration of white finishes by darkening is not the whole problem. Using certain tinting materials some of which are permanent and some fugitive in light, we can cause a white finish to become whiter when it is exposed to light. In still other cases, the vehicle itself will show bleaching when exposed to light. This function of bleaching may be continuous for several months and it may all take place within a few hours. However, test methods have been established which will produce the effect of long usage in service within a few days. These material discoloration and bleaching tendencies are extremely important to the manufacturer, and they can be controlled efficiently with the aid of the recording color analyzer.

Various methods of storage of color standards are employed; such as, wet samples, dry samples, and porcelain panels. None of these methods has proved to be entirely satisfactory. In contrast, the sheet of graphed paper having on it a definite shaped curve representing a color standard, can be stored, not only in compact form, but with absolute assurance against any change. Two or three hundred color standards can be stored in one folder occupying a few inches of space in a desk drawer.

Every paint manufacturer has to meet the complaint of unmatched color from his customers. Very often this complaint is due to very slight batch color variations. More often than not the color of a batch of material is dependent on the individual responsible for weighing the proper amount of color pigments into the paint mill. Inaccuracy of scales which become contaminated with various materials can account for some of the difficulty. Also pigment color concentrations may vary from one shipment of raw material to another, and there are many other contributing factors to the paint batch color problem. Some manufacturers go to great extremes to control the batch color, by comparing with wet standards as well as dry standards before the material is released. Others go so far as to view the color through manually operated color comparators. This latter method, of course, results in better color control than the eye comparison method, but the paint manufacturer who uses a completely automatic recording instrument need have no fear of customer complaints once he has made a color match. Furthermore, he can supply his customers with a record of the particular batch released, for his assurance.

Sometimes a customer will supply a standard of color with his order for a quantity of material. There are some very clever color men employed in the paint factories, but they can be only as efficient as their eyes will permit them to be. It would require only about three minutes to make a color record of the customer's sample, which would give a definite indication of the color necessary as well as an idea of the concentration of each ingredient. With such a picture of the color before him, the expert can go about making the combination with much less risk of error than if he had trusted his own eyesight. When a group of colors are combined to produce a material color, the mixture becomes somewhat confusing to the eye and presents illusions which are by no means helpful in the reproduction of the material.

In general, dried samples of paint are used for color measurements, which method of course requires time for drying.

The dark colors no longer present a color measuring problem, as they are measured by the expanded scale method. This method produces a color curve with the same details as the lighter colors.

It would be well to remember that every item of manufacture which is designed for home use has on it a finish of some kind or another. In a majority of cases, this is a paint finish in some particular color. Therefore, the buyer of that commodity, actually buys the finish and color because that is the only visible part. There are many instances where a manufacturer's dealer sells his merchandise in sectional parts, to which a customer is expected to add other sections from time to time. It is indeed a disappointment to the buyer to find that the last kitchen cabinet purchased does not match those already installed. The fact that it looks as good or better than the first one is no argument because the customer has already formed a mental picture of a beautiful complete unit long before he buys the first piece. That the original ones have discolored is no real argument either because the customer does not want to purchase anything with a finish that will discolor noticeably in a short period of time.

All of these color problems could at least be minimized through the use of the recording color analyzer, both for

color testing purposes and for color control work.

Exterior and interior house paints have as many different color names as there are manufacturers of them. Furthermore, what one manufacturer calls "Ivory" another may call "Cream" and a third will call the same color "Old Ivory". The chances are that all three are wrong, but who is going to prove it? As long as there is no proof, there is no control of these color terms. The color analyzer could be used to standardize these color names, and in many cases put the manufacturer in much better standing with his customers. It must be understood that the individual user has as much right as any one else to decide what is "Ivory" as long as there is no standard. If some definite standards were set up, so that each manufacturer who labeled a can of paint "Ivory" would have a true ivory color in it, then their problems would be greatly simplified and their customers far more satisfied.

Every day attempts are being made to reproduce historical building, antique furnishings, and even color schemes of famous old homes of once famous people. The type of wood is easily detected and duplicated, as is the working art. The entire building can be reproduced with remarkable accuracy. Yet these buildings and furnishings are not complete until they are nicely finished with paint materials.

Perhaps the furniture is all done in clear finishes, and the resemblance is not questioned because we know just about what to expect from nicely finished furniture made from various woods. If the exterior of the building was originally white, it can again be painted white with much less difficulty than was experienced on the original, but is it as white as the earlier white paints? Who knows what the whiteness of potash, skim milk, fish oil, and paint powder was in comparison to our present white paints? The fact that the new and the old were both white, tells us there need be no argument on that point as long as there is no correct measurement of the original whiteness available. However, consider the interiors of these old governors' mansions, with twenty or thirty intricate color schemes in the various chambers. There is probably a green bed chamber, and a blue one, also dining rooms and the reception rooms with colors varying from black and gold to light pastels. We are told that these are being reproduced at great expense, for the sole purpose of matching every detail according to record. It is true that a blue paint can be made which matches a sample taken from one of the old buildings, any more than they knew how to operate a color analyzer two hundred years ago. If some of the old governors could see our version of their executive chamber color combinations, they would probably call for a painter in a hurry.

No one knows to-day what will be important to-morrow, but we can be certain of our present color control, by recorded measurements, in the event that the colors become important during the next two or three hundred years.

The use of the "Spectrophotometer" is not confined to paint measurements alone, in fact measuring and controlling paint colors are only a small part of its usefulness. The textile industry has found the instrument to be invaluable for the purpose of controlling the color of cloth. The dye concentrations are measured by making a curve from cloth samples. These records are put on file for future use.

The paper industry, the printing ink business, and many other industries have taken advantage of this method of color control. In fact, it has been found in several instances to be of great value in the medical profession.

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Calculating the Solids Content of Reduced Organic Finishing Materials

By Willoughby G. Sheane
Chemical Engineer
General Electric Co.
Bridgeport, Conn.

The author discusses a method for calculating the per cent by weight non-volatile solids content of reduced organic finishing materials. Two equations are given along with curves showing the relative values obtainable with each. The method should be of interest to all who are concerned with the evaluation of finishing materials.

As part of the evaluation of an organic finishing material, particularly with respect to cost, it is desirable to know the percentage by weight of the non-volatile, that is, the film-forming, solids present in the material in the unreduced state. However, since relatively few finishing materials are applied without the addition of some reducer, it is more directly important that the solids content of the reduced material be known. This figure may be obtained by weighing a small sample of the finishing material, driving off the volatile portion at a slightly elevated temperature, and finally weighing the dry residue. The per cent non-volatile solids is, then, the weight of the dry residue divided by the weight of the wet sample and multiplied by 100. Where a number of different reductions are made on a material during its tests and where, consequently, a number of solids content determinations are required, it will be seen that considerable time and effort are involved.

Calculation of Solids Content

It is possible to calculate the per cent solids content of a finishing material which has been reduced, in many cases with good accuracy, without the necessity for using the time-consuming method outlined above. It is only necessary that data be known on the weight per gallon of the unreduced material, its per cent solids content and the weight per gallon of the reducer. The following equations are used:

$$Wx = \frac{(100 - X)}{100}(Wu) + \frac{(X)}{100}(Wr) \qquad \text{Eq. (1)}$$

$$Px = \frac{\frac{(100 - X)}{100}(Wu)\frac{(Pu)}{100}}{(Wx)}(100) \qquad \text{Eq. (2)}$$

Where:

Wu = weight per gallon of unreduced finishing material — pounds

Wr = weight per gallon of reducer — pounds

Wx = weight per gallon of reduced finishing material, at X per cent by volume concentration of reducer — pounds

Pu = per cent by weight of non-volatile solids in unreduced finishing material.

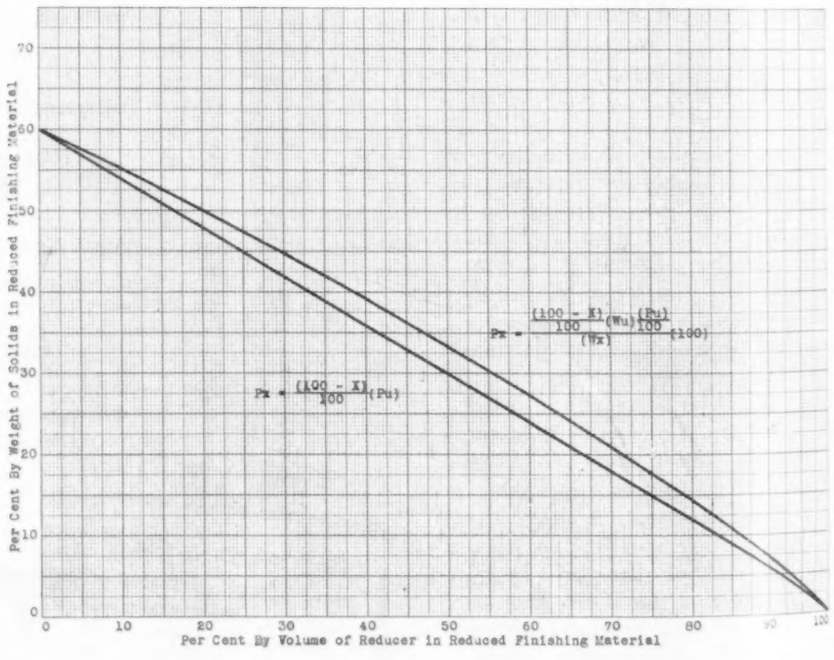
Px = per cent by weight of non-volatile solids in reduced finishing material, at X per cent by volume concentration of reducer

X = per cent by volume of reducer in reduced finishing material

100 = constant

Example

Assume that an unreduced finishing material weighs 10.0 pounds per gallon (Wu), that it contains 60.0 per cent by weight of non-volatile solids (Pu) and that the reducer used weighs 8.0 pounds per gallon (Wr). Assume further that a ratio of four parts by volume of unreduced finishing material to one part by volume of reducer is used. At this reduction, the reduced finishing material contains 20.0 per cent by volume of added reducer (X) and the per cent solids content may be obtained by substituting in Equations (1) and (2).



$$W = \frac{(100-20.0)}{100}(10.0) + \frac{20.0}{100}(8.0) = 9.6 \text{ lbs./gal.}$$

$$Px = \frac{\frac{(100-20.0)}{100}(10.0)\frac{(60.0)}{100}}{(9.6)} = 50.0\%$$

If a number of solids content data are required, as it was suggested previously, a series of per cent reducer—per cent solids content relationships may be obtained by substituting various values of (X) in Equations (1) and (2). Thus, continuing with the values for (Wu), (Pu) and (Wr) of the example above and using a range of values for (X), the following data are obtained. Figure I shows a plot of these data.

X	Px
0.0	60.00
10.0	55.10
20.0	50.00
30.0	44.68
40.0	39.13
50.0	33.33
60.0	27.27
70.0	20.93
80.0	14.29
90.0	7.32
100.0	0.00

Brief Equation

Equations (1) and (2) are based on the assumption that there is no loss or gain in volume on the addition of the reducer to the finishing material. In other words, it is assumed that if one volume of reducer is added to one volume of finishing material, two volumes will result. If there is no such loss or gain, there will be an exact agreement between the calculated values of (Px) and those actually determined by quantitative analysis.

Where less accuracy is required than that obtained from Equations (1) and (2), a brief equation may be used if it is further assumed that the values of (Wu) and (Wr) are equal. If there is no loss or gain in volume when the reducer and the finishing material are combined, the (X)-(Px) curve will approach a straight line as (Wu) and (Wr) approach each other. It is obvious that if (Wu) and (Wr) are equal, then (Wx) = (Wu) = (Wr) as shown in Equation (1) and Equation (2) takes the form y = ax + b, the equation for a straight line.

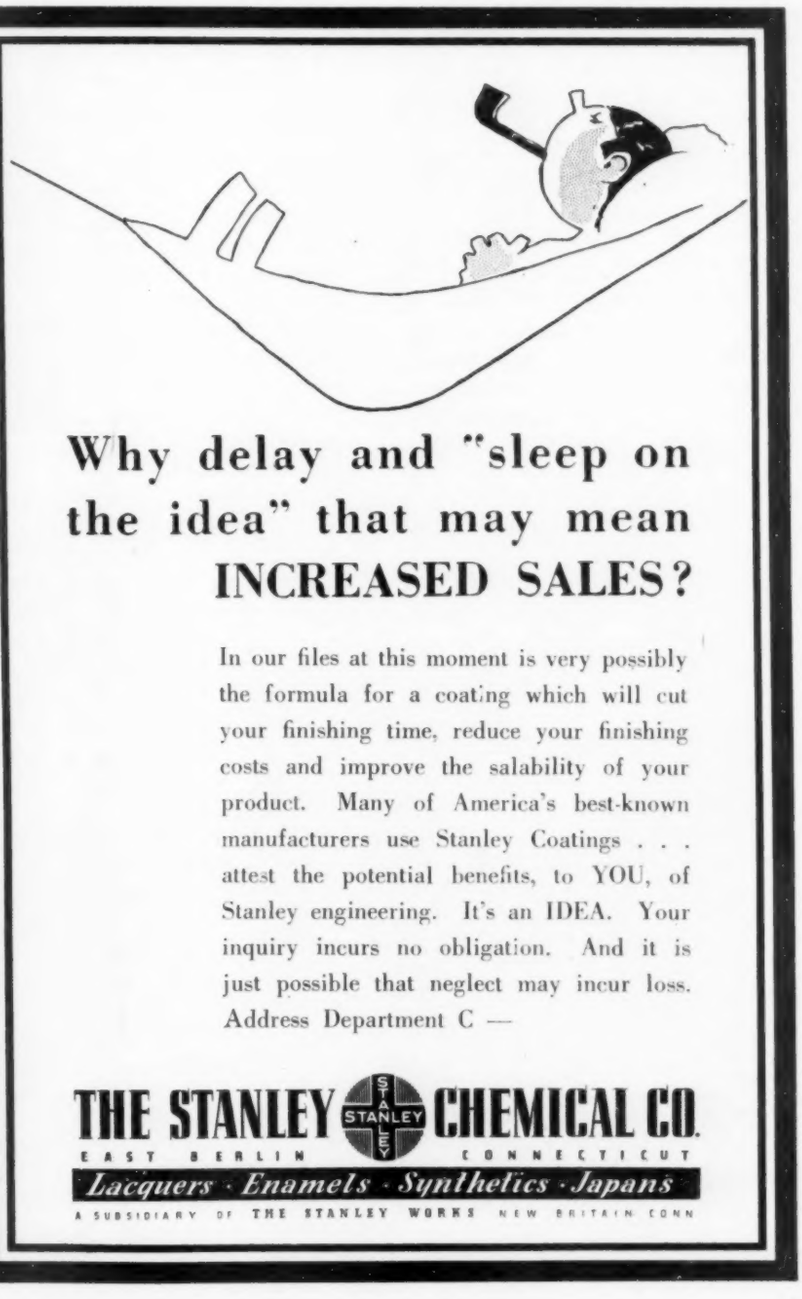
Based on the two assumptions mentioned, the brief equation is:

$$Px = \frac{(100-X)}{100}(Pu) \qquad \text{Eq. (3)}$$

For example, if the value of (Pu) = 60.0 per cent be used again, then the following values of (Px) are obtained:

X	Px
0.0	60.00
10.0	54.00
20.0	48.00
30.0	42.00
40.0	36.00
50.0	30.00
60.0	24.00
70.0	18.00
80.0	12.00
90.0	6.00
100.0	0.00

The values of (Px) in the abovementioned group of data are also shown in Figure I. The degree of agreement between the values obtained by both equations using the same original data may be clearly seen.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Detecting Moisture with Meters*

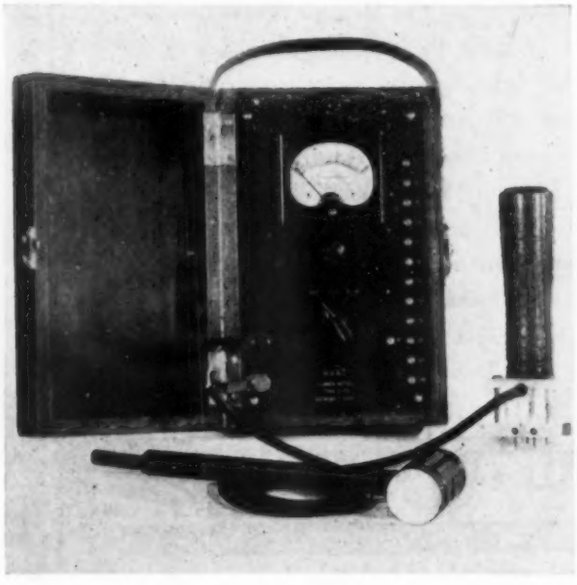
A fundamental rule for good exterior painting states that sufficient time should be allowed after a rain for the surface to dry thoroughly before the paint is applied. It is a highly important rule to follow in the painting of new surfaces, such as wood, concrete, stucco or brick, or of previously painted surfaces where the old coating has deteriorated to such an extent that moisture has free access to the underlying material. Paint applied over a partially dry surface has only a partial chance of survival. Moisture behind a paint film is the commonest cause of blistering and peeling.

The rate at which a surface will dry after exposure to rain is determined by many variables. One obvious factor is the duration and intensity of the rain to which it has been exposed. Another factor is the absorptive qualities of the material itself. Also, a surface receiving direct sunlight will dry faster than one in a shaded area. In addition, prevailing humidity and temperature conditions, wind velocity, etc. all affect the drying time.

In view of all these variables, it is not always possible from a practical standpoint to say that painting may be started a given number of hours or days after a rain. On the contrary, the common procedure is to rely on the judgment of the painter. An experienced craftsman, by observation, touch, and consideration of weather conditions, can usually determine whether or not the material is sufficiently dry for the application of paint.

Testing wood to determine moisture content.

In recent years, however, many of those in charge of extensive maintenance operations have sought more scientific and thus more infallible ways of determining the readiness of a surface to receive paint. One such method that has proved highly satisfactory in many cases is the general use of so-called "moisture meters". Several types of these meters are shown in the accompanying photographs.



One type of meter used to detect moisture in wood.

A moisture meter is a device designed to detect the presence and, in some cases, the amount of moisture in lumber and other building materials. It operates on the principle that a moisture-laden substance is a better conductor of electricity than a dry substance. In using the meter, sharp-pointed terminals are inserted in the material under test. A current is passed from one terminal to another, and a dial on the meter interprets the resistance the current meets in terms of moisture content.

Moisture meters work with considerable accuracy, particularly on wood. Not only do they indicate the presence of moisture in lumber but they also are able to show the amount present in terms of per cent. On stucco, plaster and similar materials, the meters do not indicate the amount of moisture, but they do show whether or not the particular area tested is sufficiently dry to receive paint.

In any large-scale maintenance program, an investment in moisture meters should prove well worth while. Certainly the outlay involved is less than the cost of many of the failures which might result from the application of paint to surfaces not in a fit condition to receive it.

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*Reprinted from "The Dutch Boy Quarterly," Vol. 17, No. 4 (1939)

Helpful Oven Suggestions

By Frank V. Faulhaber

Brooklyn, New York

The author offers a wealth of pertinent, constructive information pertaining to selection, installation and use of industrial ovens, including air heaters, for plants large and small. Proper care and cleaning of ovens solves many a perplexing finishing problem. Obtaining useful facts and ideas beforehand.—Ed.

In appreciable measure, the success of the metal finishing plant depends upon the ovens in use. The problem revolves not alone around the selection of the ovens, which is a major consideration in itself; proper operation and care of this equipment is essential so that the output be uninterrupted, the quality of the work uniform as desired, and the utmost be realized from the investment. The management is often steeped in perplexity when it comes to selecting the plant's ovens. There are various governing factors. Each plant has a different problem. Each plant has a different system; different methods, preferences, productions are in force. Industrial ovens for metal finishing at varying temperatures are manufactured in a wide variety of types, sizes and designs. They range from the size of a household refrigerator to some which occupy practically two floors of a long industrial building. The methods of applying heat may be studied from two points of view—source of heat and method of application. Conventional sources of heat are gas, electricity, steam, oil and butane. Steam is used, when available throughout the year, for ovens operating within its temperature range, the range depending on the steam pressure available. For ovens operating over 250° F., gas, oil or electricity is generally employed, the choice depending on convenience and economy.

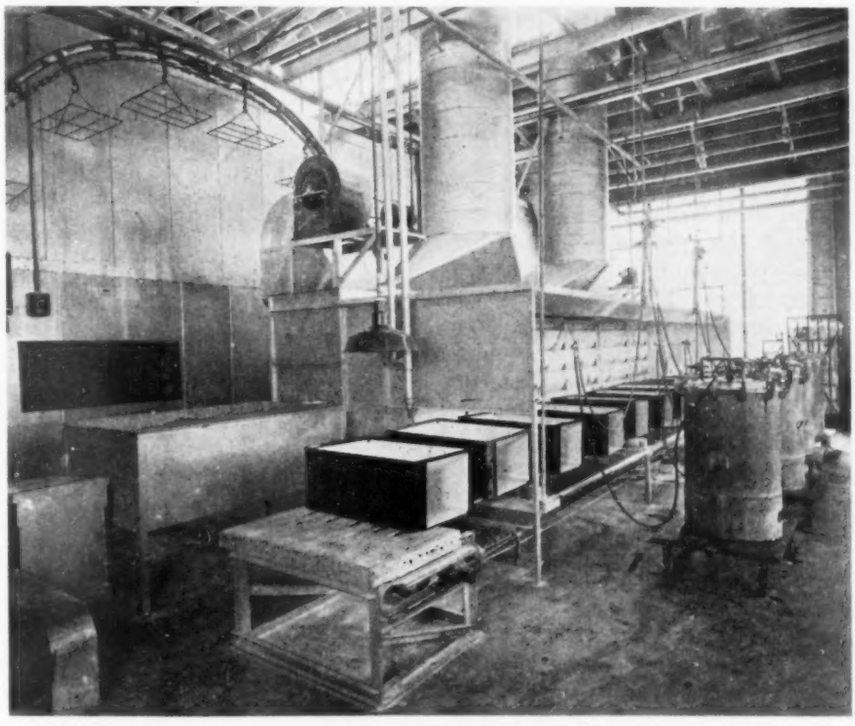
Heat Application

The methods of applying heat may be divided into: radiation, conduction, natural convection, and forced convection. Radiation, for example, the use of steam pipes, hot electric elements, or radiating gas tubes directly in the oven, is seldom used because of the resultant lack of uniformity in oven temperature. Parts directly in the path of radiant heat are over-baked, and other parts under-baked.

Conduction of heat is obtained by actual contact with the heat source, as by drying on a hot plate or roll. This method is used only in very special cases.

Natural convection is the circulation of air in a dryer or oven due to temperature difference. The rate of circulation is low, undependable, and the cause of it, difference in temperature, being undesirable in an oven, a forced convection system, wherever possible, should be chosen.

This forced system, the mechanical circulation of heated air in the oven, is the method recommended for superior results, for, when efficiently arranged, it ensures uniform temperatures, a uniform product, and a shorter baking or drying time. The material in process is heated by circulating hot air, and, since the circulation of air is rapid, the air temperature is uniform and all parts of the work are affected. Also, because of the motion of the air over the surface of the material, a more rapid transfer of heat to the work, or evaporation of moisture or volatiles takes place. However, forced convection ovens must be well designed to ensure satisfactory results. Proper consideration must be accorded to duct design, air velocities and distribution, stream-lining, turbulence, eddy currents induced flow, and the divers other factors entailed. To



Efficient and systematic arrangement of finishing equipment expedites large scale production.

particularize, even on a small batch-type single-truck oven, several methods of circulating the air may be used, the selection depending on the material itself, the method of loading, spacing and clear areas, dusting, etc.

Batch-type Ovens

Where the metal finishing plant prefers groups of batch-type ovens, it is often possible to heat these all from a single source of high temperature air, and yet control each oven independently to its own time temperature cycle.

In continuous ovens, which may take many forms, and are almost always built to meet the precise requirements of the plant, according to volume and character of daily output, it is often desirable to maintain a predetermined temperature curve throughout the oven, to efficiently process a material. This is accomplished by zoning, each zone being independent and automatically controlled.

The higher cost of continuous ovens is generally warranted where production on one article or quite similar articles is steady and comparatively large. Each oven application requires some study to determine whether the installation of a continuous oven is advisable.

Various special-purpose types of continuous ovens have been constructed using overhead monorail conveyors or other types of line conveyors, the oven becoming an integral part of the production line on many types of heavy work. Belt conveyors are frequently used for small parts.

In some tunnel ovens, counterflow between work and air is most economical since the exhaust is taken from the coolest part of the oven, whereas in others it cannot be used.

The selection of industrial ovens for the metal finishing plant depends upon the products to be finished, the amount of daily or hourly output, the entire finishing process including operations preceding and following baking or drying, the size and type of the factory building wherein the equipment is to operate, and other factors. In small ovens the finished parts may be placed in trays or on racks or trucks. A means of quick loading and unloading is essential to obtain maximum production, avoiding needless wastage of heat, time and handling and also preventing any spoilage of the work in process.

Oven Costs

The installation, operation and maintenance of ovens entails appreciable expenditure, and it is desirable for the plant management to procure maximum results therefor.

As respects the small cabinet size oven installation, the general procedure is to dip or spray the small parts in process while they are in place on trays, racks or hooks and then transfer them with minimum handling and the least possible time into the oven. The oven door is closed, temperature is brought up to the required point and held there as long as necessary to produce the desired results. Then the charge is withdrawn and allowed to cool, after which the articles are ready for any succeeding operations that may be scheduled, or they may be considered as being completely finished and ready for assembling or packing.

Ordinarily, as concerns the matter of heat application to ovens, a long and varied experience in this field would seem to be most reliable judge. This question of heating methods is assuredly no small one. The source of heated air may be: Steam, using extended surface heaters for the lower temperature range; electricity, using resistance strips placed in the air circulating system, or fuel-fired air heaters. The latter may use oil, butane, or gas and may be divided into two general classifications—direct and indirect.

In the direct or internally heated oven, the burners, or heating elements in the case of an electric oven, are built in as a part of the oven, but are located in a separate piece of apparatus in indirect, or external, firing. The simplest type of internally heated ovens for finishes has gas burners firing into metal combustion chambers near the bottom, and tubes or other type of duct up the sides and back in which the products of combustion are carried to the stack. This type of oven, although comparatively safe when well designed to prevent hot spots, gives uneven temperatures throughout the oven due to the more intense radiation near the sides, and the low air circulation velocity.

Slow Drying Speed

The initial cost of such installation is minor, but the actual cost of production, based on the number of pieces, is high, by reason of slow drying speed and possible rejects with the critical temperatures now demanded for specialized finishes.

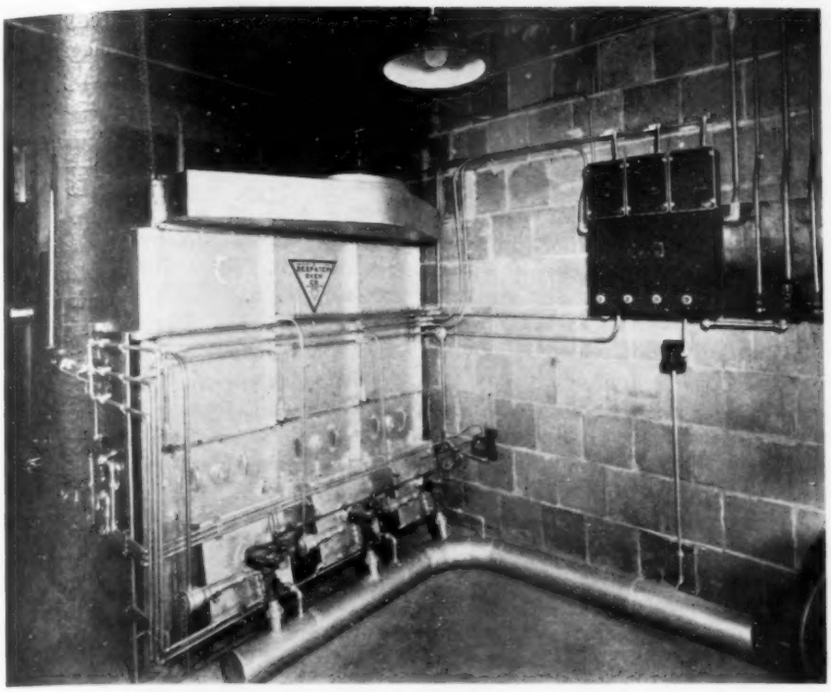
The direct type of oven is advisable where products may be circulated in the oven without harming the material processed. This method is inexpensive and is susceptible to accurate thermostatic control. Where only clean fresh air is to be circulated, the indirect type of heater is employed. This type of heater has been universally accepted by the automobile industry and other finishing plants for the baking of paints and enamels.

Provision of electric heating elements for gas burners reduces the dangerous explosion hazards in any oven baking finishes, and also gives an absolutely clean atmosphere. Its costs of installation, however, is higher than any other, except in some cases the indirect fired air heater, and except in location where the cost of electricity is low and gas high, its operating cost is also very high. The utilization of electric heating is limited to very special applications. Its ease of operation has in recent years been duplicated by manufacturers of gas control apparatus and burners, which naturally gives the gas form of heating another advantage.

The use of fans for high velocity air convection is a development designed to obviate the disadvantage of uneven heating in the natural convected oven. Thereby the burners can be located in a section baffled off from the baking chamber and the radiation effect is also greatly reduced. Expedition of the work is appreciably increased in this type of oven, and the work is uniform in quality. The cost of the added circulation is negligible, and, in a goodly number of cases, the cost per unit of work is materially reduced, so that the saving in a short time will represent a profit on the substitution of a convected air oven for an oven depending on natural convection. Correct provision of insuring even air velocity and temperature throughout the oven is essential in this type of oven to realize the utmost of its potential advantages.

Air Heaters

For continuous ovens, the air heater was introduced as a means of heating air outside the oven, being connected to the oven through piping. Air heaters have various advantages. For one thing, temperature control is simpler

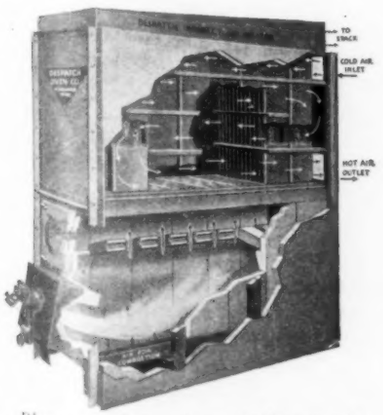


A battery of three indirect-fired air heaters for heating a baking oven. (Courtesy Despatch Oven Co., Minneapolis, Minn.)

and more exact, inasmuch as the air temperature leaving the heater will be the temperature in all sections of the oven supplied by the heater. The explosion hazard is also appreciably reduced. It ensures greater flexibility. Usually it makes for a saving of valuable space. The cost of installation and maintenance is comparatively low.

The first type of air heater developed was of indirect operation, where the products of combustion did not mix with the air supplied to the oven, but heated the air through tubes. With this type of heater there is no possibility of contamination of the air transmitted to the oven from the fuel, so that the most difficult finish can be processed without the possibility of marring defects through its use.

Of more recent origin is the indirectly fired type of external air heater. In this type the products of combustion are directly mixed with the air that is recirculated through the oven, sufficient air being exhausted from the oven to reduce the solvent concentration below the explosion point. With this method the efficiency of utilization is very high. Further advantages over the indirect fired air heater is its lower initial cost and, in most instances, lower maintenance cost. Its cleanliness of air is adequate for most bake finishing operations when the proper fuel is used.



Phantom view of an indirect air heater. (Courtesy Despatch Oven Co., Minneapolis, Minn.)

Explosion Hazard

In the indirect air heater the explosion hazard is also minimized because the inflammables evaporated by the recirculating air are partially burned in passing through the heater.

Another point in favor of air heaters is that, inasmuch as they may be set up anywhere, valuable floor space is thus released for other machines and purposes, the heater being locatable on the roof, underneath the oven, or, frequently, in space otherwise wasted.

Again, air heaters may utilize waste heat from another process if that available is sufficient in temperature and quantity. Worthwhile savings can be effected in operating costs, thereby, in most cases, but the individual case determines the requirement, therefore investigation along this line is in order, companies that have the necessary, precise experience, combined with comprehensive research and planning, being glad to furnish technical advice.

By reason of the varied utility of the air heater, old ovens using natural convection with steam or gas heating can be modernized at small outlay by installing an air heater, fan, and ducts for proper air distribution, provided the oven housing is in workable condition. When the oven is of the type most suitable to economical processing of the product, appreciable savings often are realized in this way that otherwise would entail installation of new ovens and equipment.

Air heaters are not confined solely to continuous conveyor ovens, but may be applied to all types, such as batch or box type, intermittent tunnel or conveyor type, etc. The method of applying the heated air will vary with each installation, being designed to give the maximum efficiency and uniformity obtainable. Where groups of small ovens are already installed, or production demands indicate that a group of independently operated ovens are more desirable than one large oven, the air heater unit can be operated as a central source of high temperature air, which may be distributed automatically under thermostatic control to each of the small ovens. Each oven then may be operated independently with its own time temperature cycle. Here, once more, the benefit of air heater operation is obtained, but the first cost is relatively nominal, since it is distributed over a number of ovens.

The method of handling material in an oven is governed not only by the material itself, but also by the location of the oven in the plant production schedule, or the processing of the material before and after the oven cycle. To illustrate, for a continuous flexible sheet being coated on one side, a straight pass or festoon dryer could be employed, whereas for 2-side coating, a tower dryer or horizontal festoon might be in order.

Wall Construction

Another important consideration in the selection of industrial ovens is the type of wall construction. In the interest of cost curtailment it is meet not to overlook the value of proper

insulation of ovens. A low initial cost obtained by using insufficient insulation or a low grade insulation or both, never fails to result in high baking cost over a period of years.

The predominating type of construction for bake-finishing ovens is the insulated panel, made of two sheets of metal separated by rock wool, aluminum foil, or other insulating material. The thickness of panel is determined by the temperature to be maintained, greater insulation being required for higher temperatures.

The selection of insulating material is influenced by a number of factors. For example, as respects the temperature range, an asbestos paper will not withstand the same temperature as rock wool. Secondly, as respects the specific application, a high vertical panel filled with rock wool, must have the blankets properly reinforced to obviate sag or bulge. Ordinarily, ovens should have two or more inches of rock wool insulation in all walls, depending upon operating temperature, and a minimum of metal joining the inside and outside of the oven. Thirdly, as respects the weight or heat retention, aluminum foil, for example, has practically a very low volume weight and, consequently, no heat retention.

Furthermore, the type of metal employed for the panels depends on the service involved. All modern ovens for temperatures lower than 500° F. are best built of panels with permanently protected insulation enclosed between the inside and outside sheets. Corrosion or appearance may dictate the use of galvanized iron, copper, aluminum, alloy steel, or vitreous enameled sheets, but the majority of ovens are built of black steel painted to suit the plant surroundings.

Insulating Brick

Where the temperatures run above 500° F., the use of insulating brick as a construction material should be considered. This is a comparatively new type of light weight brick with a thermal conductivity very much lower than common brick or fire clay brick.

Fully as important as the materials from which they are made is the construction of the panels. Strength they must have, and rigidity, so they will not get out of shape; there must be no projections to interfere with cleanliness or appearance; they must have tight joints to prevent leakage; they must have a minimum of "through metal" to prevent loss of heat; and they must be adaptable to suit the structure to which they may be attached.

Panel construction of the ovens permits complete fabrication in the manufacturer's plant and easy assembly in the metal-finishing factory. It lends itself to increasing oven size at a later date, and to dismantling and reassembling at a different location when necessary. It is this type of oven construction that has been adopted by the majority of the automobile manufacturers. Panel construction may be used for batch-type ovens, tunnel-type ovens, or overhead conveyor ovens. It has been used for ovens approximating a 6-ft. cube, and for ovens many hundred feet long.

The floor, which too frequently is left bare, should be insulated in all cases where possible, for it is a source of great heat loss. In the older metal-finishing plants there are a great number of oven installations which could decrease baking and drying costs and increase production by modernization or replacement with the latest oven designs. A review of the individual plant, objectifying for desirable improvement in the ovens and kindred equipment, may amply repay the time entailed.

It is desirable, incidentally, wherever possible, to keep ovens away from all wood structure in the plant, such as window frames, columns, and the like; at a sufficient distance, in fact, to meet with any fire regulations or insurance requirements, as may be in force.

The choice of conveyor design is frequently governed by the method of applying heat. Requirements of counterflow or parallel flow and free area between parts and other air handling problems will often prescribe the particular type necessary.

Cleaning Routine

The prevailing requirement is to clean ovens at least twice a week, depending upon the amount of work put through. This was a routine hitherto often unthought of. Now the practice is followed diligently and unfailingly. The foreman of the finishing department discontinued the practice of painting the interior of an oven, declaring that eventually the coating would flake, and flakes would drop and adhere to the work. This gives inkling of another run of finishing troubles that sometimes perplex the management.

Considerable of a finishing plant's products often contain marring particles by reason of unclean, dusty ovens. However minute, these interfering specks do not make for superior quality of workmanship. Sometimes this inferiority is tolerated, gambled on; some of the customers receiving the final work, remark upon it, complain, ship back consignments, discontinue their patronage.

All unnecessary. By giving a brisk rubbing and cleaning to the entire interior of the oven, including all the fixtures that too often are given but scant, haphazard cleaning, improved work will be the result. Racks, rods, hooks and corners should be thoroughly, carefully cleaned, using benzine or turpentine, or some other good cleaning fluid on a rag to remove hardened scale. By spraying uniformly with water, then turning on heat for about half an hour, a cleaner oven will be the result. It would be a forward-looking practice, whenever possible, to maintain in the plant extra ovens, depending upon the plant's output and capacity, to cover any emergency, and so as to permit proper and regular cleaning. The added expense would be amply repaid by the resulting improved output.

By aid of a vacuum cleaner dust and other objectionable particles can be speedily removed, thus making for a satisfactory job. Whenever such cleaning is done, care should be exercised by the workers to keep down the dust as much as possible. Opening and closing the doors hurriedly adds materially towards specked work.

Dust Hazard

All paraphernalia about the finishing operations should be as free as possible of dust under the operating conditions. Dusty operations, such as, for instance, the application of asphaltum powder on printed, etched metal plates, is one outstanding reason why inferior work is the outcome at the finishing operations. Avoiding drafts, especially while finishing is being done, will reduce questionable work at the operation. Periodical supervision and attention to this responsibility will assuredly conduce towards a better quality of product. The additional care, conscientiously exercised, will have its salutary effect on the plant workmen, who should turn out superior workmanship.

Diacetone Alcohol

(Diacetone, Pyranton A, Diacetonyl Alcohol, Alco, Deo, 4-hydroxy-2-keto-4-dimethyl pentane)

Physical Properties

Diacetone alcohol is a flammable organic liquid having a particularly mild, mint-like odor. When pure, it is colorless, although commercial grades range in color to that of light straw. It is one of the ketonic alcohols and has the molecular formula $(CH_3)_2C(OH)CH_2COCH_3$. Its molecular weight is 119.096, twice that of acetone. Because of its molecular structure, diacetone alcohol has the characteristics of both a ketone and an alcohol.

Diacetone alcohol is miscible in all proportions with water, ethyl ether and ethyl alcohol and comparatively so with most organic liquids such as aromatic and halogenated hydrocarbons, alcohols, esters, etc. With water it forms a constant boiling mixture, containing about 74% water by volume, which boils at 99.7°C. It is an excellent solvent for nitrocellulose and cellulose acetate and will dissolve many natural and synthetic resins including copals, mastic, rosin, ester gums, Bakelite and so forth. It will also dissolve oils, fats, tars and dyes.

In many respects diacetone alcohol is quite similar to acetone, the great difference being in the rate of evaporation. Its evaporation rate is much lower than that of acetone. Compared with ethyl ether (taken to have a value of 1) its volatility is 147, or about fifty times greater than acetone. Further, whereas acetone is considered a low boiling liquid (boiling point 56.1°C. at 760 mm. pressure) diacetone alcohol is a relatively high boiling material (see below).

Diacetone alcohol is listed as having a specific gravity of 0.937 — 0.943 at 20°C./20°C. (approximately 7.81 pounds per gallon), a boiling point of 166.0°C. and a melting point of —54 to —57°C.

Manufacture

Diacetone alcohol is obtained commercially by the condensation of two molecules of acetone in the presence of an alkaline catalyst.

$$(CH_3)_2CO + CH_3COCH_3 = (CH_3)_2C(OH)CH_2COCH_3$$

The reason for the molecular weight of diacetone alcohol being twice that of acetone can plainly be seen in the above reaction.

Under ordinary conditions, the yield of diacetone alcohol from the condensation of acetone is not very great inasmuch as there is a strong tendency for the diacetone alcohol to decompose. However, through the use of a special apparatus known as the Soxhlet extractor nearly all of the acetone may be converted by the continual separation of the diacetone alcohol from the acetone as it is formed.

Diacetone may also be made by a reaction involving a special organic compound and nitrous acid.

Uses

Diacetone alcohol is of particular value for many and widely varying industrial purposes. For use in lacquers and cellulose acetate dopes, it is a standard slowly evaporating solvent. Its presence in a solvent mixture imparts good gloss to films of lacquers and small amounts very favorably affect flow during drying. It finds special use in cellulose ester brushing lacquers because its attack on dried films is very slow.

Large quantities of diacetone alcohol are used in anti-freeze solutions, preservatives for animal tissue and wood, non-grain-raising wood stains, metal cleaning compounds, hydraulic compression fluids, dyes and cements. It finds further application in making artificial silk and leather, in the imitation of gold leaf, in the extraction of resins and waxes and in the manufacture of certain synthetic resins.

Physiological Properties

Literature on solvent toxicity does not show that experiments have been conducted on the inhalation of diacetone alcohol vapor or that any toxic effects on human beings have been recorded. However, experiments on animals indicate that its action is similar to that of acetone but somewhat more toxic.

Specifications and Properties

The following are data on two grades of commercially available diacetone alcohol.

	Acetone-free	*Technical*
Specific Gravity	0.937 — 0.943 at 20°C./20°C.	0.923 — 0.927 at 20°C./20°C.
Purity		Contains not more than 10% acetone and conforms with the specifications of the U.S. Army Air Service.
Acidity	Not more than 0.05% calculated as acetic acid.	Not more than 0.01%, calculated as acetic acid.
Color	Water-white to light straw.	Water-white to light straw.
Water Solubility	Miscible with distilled water in all proportions without turbidity.	Miscible with distilled water in all proportions without turbidity.
Water	No turbidity when one volume is mixed with 19 volumes of 60°Baume gasoline at 20°C.	No turbidity when one volume is mixed with 19 volumes of 60°Baume gasoline at 20°C.
Non-volatile Matter		Not more than 0.01 gram when 100 cc. are evaporated on a water-bath and heated to constant weight at 105°C.—110°C.
Distillation Range	Distills between 130°C. and 180°C. Approximately 85% distills between 150°C. and 170°C. At atmospheric pressure slight decomposition occurs but at reduced pressures distillation can be accomplished without decomposition.	Distills between 60°C. and 180°C., with not more than 20% below 100°C. Approximately 75% distills between 150°C. and 170°C. At atmospheric pressure slight decomposition occurs but at reduced pressures distillation can be accomplished without decomposition.
Boiling Point	164°C. to 166°C. at 760 mm. of mercury	
Melting Point	—44°C. to —45°C.	Approximately —63°C.
Flash Point	About 55°C.	4°C. to 14°C.
Coefficient of Cubical Expansion (at ordinary temperatures)	0.00095 per °C.	0.00091 per °C.
Weight per U.S. gal.	7.81 pounds at 20°C.	7.72 pounds at 20°C.
Refractive Index	1.4242 at 20°C.	1.3712 at 20°C.
Odor	Mild, pleasant	Mild
Vapor Pressure	3.3 mm. of mercury at 20°C.	
Heat of Combustion	8,601 calories per gram	

NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

Pad for Disc Sanders

A new lightweight back-up pad for disc sanders has recently been developed by the Columbian Rope Co. of Auburn, N. Y.

The pads are available in the normal sizes, 7″, 8″ and 9″, with a molded plastic center. Both the center and the flexing surface are made of rope fibre, bonded and molded to prevent separation.

Lightweight back-up pad made of bonded rope fibre for disc sanders.

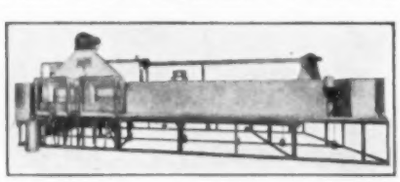
The new pad is recommended for sanding and polishing metal or wood surfaces, and the 7″ pad weighs less than one-half pound.

The old type nut, bolt and plate assembly is eliminated by the tough molded center and the balance obtained is stated to reduce vibration. These pads will be made available through manufacturers of disc sanders.

Automatic Air Finishing and Drying Unit

This Automatic Airfinishing and Drying Unit is designed for enameling flashlight cases and other similar items up to 18″ in length and baking the finish at temperatures ranging from 200° to 400°F. The conveyor is equipped with 1605 revolving spindle assemblies mounted at 2½″ centers and the speed of the conveyor is controlled to conform to any drying cycle required.

The drying oven is built in two sections to provide 200° temperature in the first section and 400°F. in the second section, with 5 minutes allowed for forced cooling after the pieces leave the oven. On a drying cycle of 5 minutes in the 200° section, 15 minutes in the 400° section, and 5 minutes force cooling, the speed of the conveyor is regulated to produce 52½ finished pieces per minute. The oven unit is insulated with 3″ rock wool and is electrically heated and thermostatically controlled. Removable tops are provided for easy access to the interior of the oven and 75% of the bottom area of the oven is equipped with counter weighted doors to insure against explosion hazards.



Automatic airfinishing and drying unit for enameling flashlight cases.

The coating section is equipped with two spray booths, one for automatic operation and the other for manual or experimental purposes. This unique feature increases the value and utility of the unit as it serves the dual purpose of a complete production unit plus the added feature of adapting it for experimental and new development work.

Overall dimensions of the conveyor are 35′0″ long by 11′0″ wide with approximately 336 feet of steel roller chain mounted on ball bearing sprockets and equipped with ball bearing chain take-up. Paasche Airbrush Co., 1909 Diversey Parkway, Chicago, Illinois.

Low Cost Painting Outfit

Binks Manufacturing Co., 3114 Carroll Ave., Chicago, Ill., have marketed a ¼ H.P. painting outfit which features a single diaphragm compressor with pulsation chamber in one piece with compressor head. A sealed crankcase provides lubrication for life of compressor. The delivery is 2.2 C.F.M. at 26 pounds working pressure.

Low cost painting unit.

The unit comes with an internal atomization bleeder type adjustable spray gun and quart pressure cup. The gun is equipped with a flat spray nozzle and with a moisture filter.

School for Finishers

The DeVilbiss Company announces the schedule of their training school for the first half of 1940. To be held in the Company's Toledo plant, the school is open to industrial painters, master painters, automobile refinishers and all others interested in learning the technique of spray-painting and the use and care of spray-painting equipment.

Each training period lasts for one week. The first class opened January 8th. Others begin on the following dates: March 4th, April 11th, May 6th and June 3rd.

Special rates in Toledo hotels and boarding-houses near the plant have been secured by the Company for men attending the school.

These classes have been well attended in the past because of the facilities for study otherwise unobtainable, offered by the DeVilbiss Laboratories.

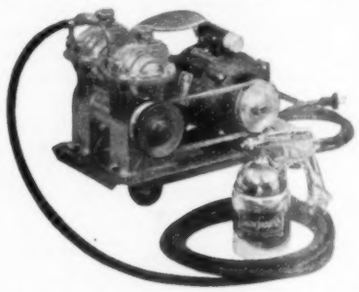
It is advisable to enroll in the school as far in advance as possible, since the size of the classes must be limited, and since there will be no training period other then those announced.

Complete information may be obtained by writing The DeVilbiss Company, Toledo, Ohio.

New Series Paint Spraying Units

The Electric Sprayit Company, Sheboygan, Wisc., have recently designed new easily portable paint spraying units with twin cylinder compressor for general maintenance painting, for small production work in industrial plants, and for refinishing.

The compressor is driven by a ½ H.P. electric motor or a ⅝ H.P. gasoline engine.



Portable paint spraying unit with twin cylinder compressor.

The compressor displacement is 5.10 C.F.M. and the spraying pressure is 40 pounds.

The spray gun, which is of the pressure feed, internal mixing type, is furnished complete with round and fan spray nozzles, as well as with an angle nozzle for spraying parts difficult to reach.

Manufacturer's Literature

Centrifugal Enameler. A four page illustrated folder describing centrifugal enamelers of the Tolhurst Centrifugal Division, American Machine and Metals, Inc., 100 6th Ave., New York City. These enamelers are for applying organic coating to small

parts. The parts are placed in a removable container, either loosely or for special types of work, on racks, and a sufficient volume of coating material is flowed in so that the parts are completely covered.

The centrifugal pressure developed on whirling is said to force the enamel uniformly into even minute openings. Continued rotation removes excess.

Disc Sanders. The literature describes new lightweight portable disc sanders, which feature straight line ventilation, balance, and smooth running. Skilsaw, Inc., 5043 Elston St., Chicago, Ill.

Power Tools. "Gaston Bull-Dog Snaggers" is the name of a folder recently distributed by Gaston Power Tools, 2657 W. 95th St., Evergreen Park (near Chicago) Ill., which illustrates simple, rugged, lightweight, portable grinders; also suitable for buffing.

News

M. W. Lightcap, formerly with Pittsburgh Plate Glass Company, has been appointed Manager of Maintenance Sales for the Devoe & Raynolds Company, it was announced today by *E. S. Phillips*, President. He will make his headquarters in New York.

Mr. Lightcap was associated with Pittsburgh for the past 15 years, engaged, for the largest part of that time in paint sales and maintenance work. He helped organize that company's paint Maintenance Service Department, of which he was supervisor for the past 5 years.

He has a wide acquaintance among building maintenance engineers in many industries, particularly textiles, iron and steel, petroleum, food, cereal, milling and public utilities, as well as in the insurance, office building, apartment house and hotel fields.

According to the *Hilo Varnish Corp.*, Brooklyn, N. Y., exhibitors at the 6th International Heating and Ventilating Show, considerable interest was shown in various smooth, gloss and semi-gloss, tough, quick-bake type of finishes, and in particular, smooth surface two-tone hammered metal effect and the new smooth gloss spatter finishes.

At the *Despatch Oven Company's* (Minneapolis, Minn.) stockholders annual meeting, the following officers were re-elected for 1940: *A. E. Grapp*, President and Treasurer; *H. L. Grapp*, Vice-President and General Manager; *G. C. Keyes*, Vice-President and Chief Engineer and *F. H. Faber*, Secretary and Sales Manager.

Progress during 1939 was summed up at the meeting.

Dr. Joseph Mattiello, Director of Research and Industrial Sales, *Hilo Varnish Corp.*, Brooklyn, N. Y. lectured on "Vehicles and the Raw Materials Used in Them" (covering both lacquers and oleoresinous vehicles), on January 29th, at the Fogg Art Museum of Harvard College. The lecture was one of a series in Paint Technology, sponsored by the Massachusetts Department of Education, Division of University Extension, with the cooperation of the New England Paint and Varnish Production Club, the Paint and Oil Club of New England, and the Paint Salesmen's Club of New England. This group of lectures plays a large part in disseminating fundamental knowledge which is essential to intelligent handling and application of protective and decorative coatings.

Grover M. Hermann, President of the *American Asphalt Paint Company*, Chicago has just announced the purchase of the *Casein Paint Division* of the *Beatrice Creamery Co.*

Casino Paint is the brand name established two years ago for this casein paint. The name and entire distribution set-up will be carried on by the new owners.

Manufacture of Casino Paint has already been started at the Kankakee plant of the American Asphalt Paint Co., who also operate plants at Lincoln, New Jersey; Marietta, Ohio; and High Point, North Carolina. Mr. Hermann states that service to Casino customers will not be interrupted and because of strategically located plants should be materially improved.

Sales of Casino Paint are to be under the direct supervision of *J. G. Brown*, Vice President, who is in charge of the present Casein Division of the American Asphalt Paint Company.

Prior to the acquisition of Casino Paint

WALKER'S
NO. 711 ZINC CHROMATE PRIMER

¶ Comes in various colors

¶ Air dries in 20 minutes to take Lacquer or Synthetics without *lifting*

¶ Can be Forced Dried or Baked

¶ Excellent adhesion to die cast metal

¶ Good resistance against Moisture Penetration and Salt Spray Test

H. V. WALKER CO.

FINISHES TO FIT YOUR PRODUCT

OFFICES and PLANT

ELIZABETH - - - - NEW JERSEY

New England Representatives — BROWN & DEAN CO. — Providence, Rhode Island

from the Beatrice Creamery Co., the American Asphalt Paint Company were large producers of Casein Paint and have had years of experience in manufacturing this increasingly popular type of paint. It is felt that Casino customers will benefit from the extensive research and experience that American has had in this field.

This purchase is in line with the extensive expansion program of the American Asphalt Paint Company. Other recent enlargement activities of this company include an expenditure of approximately $100,000 at their Kankakee plant for a modern lacquer plant, for additional varnish making equipment, for a complete stain and filler manufacturing department and additional high speed paint grinding equipment.

Organic Finishing Digest

Evaluation of Nitrocellulose Lacquer Solvents

By V. W. Ware and W. M. Bruner
(Industrial and Engineering Chemistry, January, 1940)

Data obtained by the constant viscosity procedure for nitrocellulose solvent evaluation are presented for three types of hydrocarbon diluent: pure coal tar (toluene), pure aliphatic (gasoline), and mixed aromatic-aliphatic or so-called high-solvency naphtha. These diluents have been studied in conjunction with four commercially available esters: isobutyl acetate (90%), n-butyl acetate (90%), isobutyl propionate (80%) and pentacetate (87%). The comparisons were made in the presence of nitrocellulose alone and also with a 2 to 1 mixture of nitrocellulose and resin.

The value as a diluent decreases in the order, toluene, high-solvency naphtha, gasoline; this decrease is considerably greater with nitrocellulose-resin mixtures than it is when the nitrocellulose composes the entire make-up of the solids ingredients, but in no case is it enough to be of any great practical value until a dilution beyond 20% is used.

The complete similarity and equivalency of isobutyl acetate and n-butyl acetate, as concerns their solvency characteristics and diluent acceptance with the three types of hydrocarbons throughout the entire dilution range at spray viscosity, is demonstrated. This equivalency is not noticeably affected by the presence of resin in the formulation.

The superior solvent strength of isobutyl propionate as the high-boiling ingredient of nitrocellulose lacquers is shown.

Airplane Dopes

Relation of Tautening and Weathering Qualities to Composition

By Frank W. Reinhart and Gordon M. Kline
National Bureau of Standards, Washington, D. C.
(Industrial and Engineering Chemistry, Feb. 1940)

In a previous report on developing a fire-resistant airplane dope to replace the hazardous cellulose nitrate product, formulae for experimental dopes for application to fabric-covered test panels were selected on the basis of the effect of plastic, plasticizer, solvent and diluent components on the shrinkage and flexibility of dope films. This report describes the exposure tests of these experimental dopes and discusses the relation between the tautness and weathering properties of the doped fabrics and the composition of the dope.

Evidence is presented to show that the hydroxyl content of cellulose mixed esters is especially critical in determining their suitability for use in airplane dopes. Solvent combinations and plasticizers which yield optimum tautness, resistance to slackening in wet weather, and least variation in tautness during exposure are indicated for various cellulose derivatives. A close correlation is shown to exist between the properties of the unsupported films and the behavior of doped fabrics; a considerable saving thus results in time, labor and materials in evaluating new compounds and formulae.

Patents

Lacquer. Walter J. Clarke (to Bell Telephone Laboratories, Inc.) U.S. 2,170,187. August 22, 1939.

A lacquer resistant to perspiration, is formed of various volatile solvents together with the following:

Nitrocellulose	52
Alkyd resin	18
Dibutyl phthalate	15
Impalpable powder of silica gel	15 parts

Paint Compositions Containing Casein, etc. Joseph V. Reardon (to Reardon Co.). U.S. 2,174,094. Sept. 26, 1939.

A dry powder paint composition which, when mixed with water, applied and dried, becomes washable, and is comprised of casein and a water soluble aluminate, such as sodium, barium or calcium. The aluminate, being active both as a solubilizer and insolubilizer for the casein, and which is of such substantially neutral reaction. The compositions are devoid of ingredients which after being mixed with water, applied and dried, are soluble in water.

Finely Divided Copper. No. 2,183,202. Paolo Misciattelli, Rome, Italy.

The process for precipitating copper in finely divided form upon a surface, comprises reducing a copper solution in the cold with formaldehyde; said solution containing cuprotartrate, gum arabic, caustic soda, and a catalytic amount of silver compound.

Agateen LACQUERS

All types of Clear Lacquer for Metals

BUFFING LACQUER

for Cloisonne Reproductions
Air-Dry Priming Lacquer
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Elastic *Non-blushing*

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Agateen —*The Last Word in Quality*

ENTHONE

BAKED ENAMEL STRIPPER

Baked enamels removed swiftly and cleanly. No smut—no pigment deposits to wipe off.

Economical—Use 3 parts water—1 part stripper. Enthone Stripper is not consumed during stripping and drag-out is only loss.

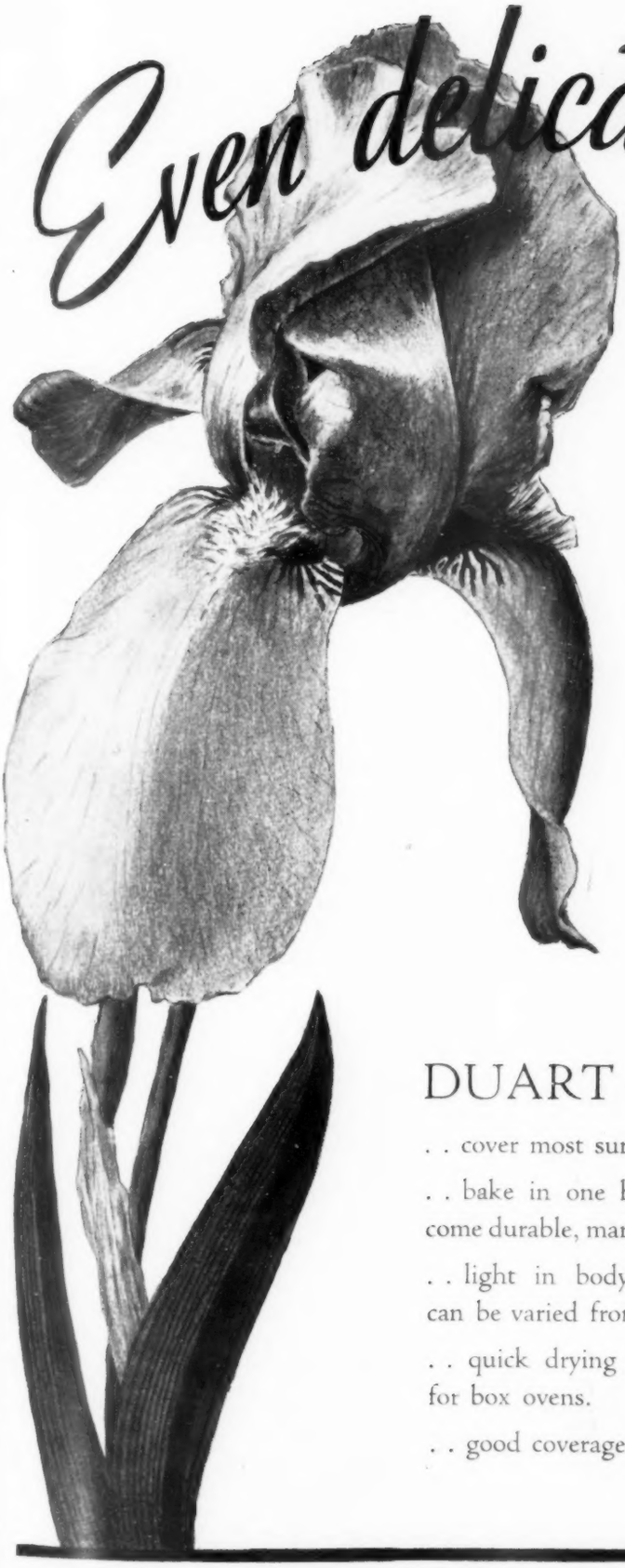
Non-Corrosive—No attack on aluminum, magnesium, zinc or other metals.

Glyptal, urea-formaldehyde, resyl, bakelite, and other baked enamels often stripped in less than a minute.

Write today for a sample and information for cutting your enamel stripping costs.

The ENTHONE Co. Chemical Products
NEW HAVEN, CONN.

Even delicate colors



can now be applied on rough surfaces in only one coat

• Because you can apply most colors—even white, pastels, or clear—directly to rough surfaces without priming, sanding, removal of tool marks, or other preparation, Duart Wrinkle Enamels are the most economical type of finish for many kinds of metal products.

DUART WRINKLE ENAMELS

. . cover most surface defects effectively in one coat.

. . bake in one hour or less, at low or medium heat, and become durable, marproof, resistant to heat, moisture, alcohol, grease.

. . light in body, easily sprayed, easily touched up. Patterns can be varied from fine to coarse, as desired.

. . quick drying types for conveyor ovens, slow drying types for box ovens.

. . good coverage.

Send for full information

Maas and Waldstein Co. Newark, N. J.

Branch Offices and Warehouses . . . 1658 Carroll Ave., Chicago . . . 1228 W. Pico Blvd., Los Angeles

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WILL YOUR PRESENT WRINKLE FINISH DO THIS?

1
Assembled machine is absolutely UNIFORM in appearance — all parts perfectly matched
2
Leading sewing machine manufacturer finishes parts with Rincon-trol BEFORE assembly

LIKE this sewing machine manufacturer, you can finish parts with Rincon-trol wrinkle finish *before* assembly . . . and with perfect *safety!* Or if you prefer, you can apply Rincon-trol *after* assembly. • In *either* case, you'll find the finish of your product absolutely uniform . . . in texture . . . in appearance . . . in durability. • Rincon-trol sharply reduces rejects through elimination of sags, "fish eyes" and fatty edges . . . smooths out production flow by permitting quick, easy repair on the assembly line . . . steps up sales by giving your product a quality finish at low cost. • It will *pay* you to investigate Rincon-trol. Write today for samples and complete information. Prompt deliveries are made to manufacturers in the Middle West from our Chicago warehouse.

Roxalin Flexible Lacquer Co., Inc.
BOX 633 ELIZABETH, NEW JERSEY

ROXALIN *Flexible* FINISHES

A FINISH TO MEET EVERY PRODUCTION REQUIREMENT

Harold R. Smallman

Harold R. Smallman, for many years in charge of the Chicago District Office of the Hanson-Van Winkle-Munning Company of Matawan, N. J., manufacturers of electroplating equipment and supplies, has been made Western Manager of the Company.

Mr. Smallman's business career embodies a broad experience in the electroplating industry as well as early shop and field training as an electrician. In 1916 he joined the Howe Electric Company of Chicago, staying with them until the War. In 1917 and 1918, he was in the 108th Engineers, 33rd Division, and after his discharge, he rejoined the Howe Company, remaining with them until 1920, when he left to go with the Armour Company. In 1921 he joined the forces of A. P. Munning and Company, manufacturers of electroplating equipment and supplies.

For four years he served that company as a salesman in the Illinois, Indiana and Iowa territories. In 1925, he was moved to the headquarters of the company in Matawan, N. J., as a sales executive. In 1927, A. P. Munning and Company was merged with the Hanson-Van Winkle Company to form the Hanson-Van Winkle-Munning Co., and Mr. Smallman continued to act as sales executive for the combined organization. In 1929, he went back again to the Middle West as District Manager of the Chicago territory where he has remained to date. His appointment to the post of Western Manager broadens his responsibilities to include executive as well as sales supervision.

Harold Smallman is one of the most popular figures in the organization. His energy, his knowledge of the electroplating industry, his tact and his ability to make friends have been assets of great value both to himself and to his organization. He has a large and flourishing family —a wife, three boys and two girls—but he still has time for golf, fishing and bowling.

Mr. Smallman has the good wishes of all of his business associates and of his many friends throughout the trade in the territory which he has so long served.

THE **ROBERTS WAY**
assures **BETTER FINISHES**
with uniform production economy.

ROBERTS ROUGES and BUFFING COMPOUNDS exactly meet all operating conditions on every type of metal.

Please specify YOUR requirements and samples for convincing trial will be SENT PROMPTLY.

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Specialists in manufacturing of gold, sterling, and silver plate rouges; stainless steel, chrome, and crocus compounds.

Barrel Finishing

for Better plated surfaces

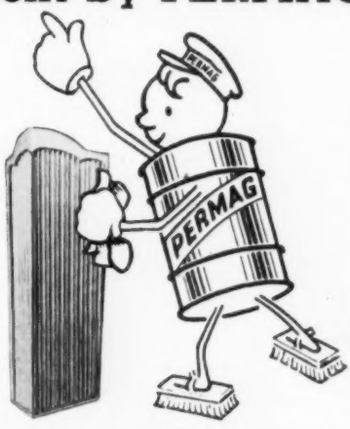
Prepare for a fine plate first by burnishing small, metal parts. After plating, burnish again. That rolls down the surface, closes pores, increases resistance to corrosion. Pressure does the job. Therein lies the advantage of Abbott high, narrow barrels which take a charge of several hundred pounds of steel burnishing materials. This mobile weight, confined within an upright area, develops maximum pressure on the work. Questions gladly answered. Orders promptly filled.

The Abbott Ball Company
1046 New Britain Ave. Hartford, Conn.

Cleaned 100 per cent by PERMAG
—ready for Chrome Plating

PERMAG Cleaning Compounds are used extensively in chrome plating shops. PERMAG cleans surfaces, difficult parts, crevices, depressions in odd shaped pieces chemically clean for plating.

Motor car grilles and similar objects are cleaned by PERMAG quickly, efficiently and at low cost. Write for prices and details.



MAGNUSON PRODUCTS CORPORATION
Main Office and Factory, Third & Hoyt Sts., Brooklyn, N. Y.
Representatives, also Warehouses in Principal Cities of United States
In Canada: Canadian Permag Products, Ltd., Montreal and Toronto

L. R. Westbrook, formerly assistant director of the Cleveland, Ohio Experimental Laboratory of the Grasselli Chemicals Department, E. I. du Pont de Nemours & Company, has been appointed research manager of the Company's Electroplating Division. In his new position Mr. Westbrook assumes charge of all electroplating research activities of the du Pont Company. He will continue residence in Cleveland.

L. R. Westbrook

W. B. Lawson has resigned as vice-president of the Harshaw Chemical Company, Cleveland. Mr. Lawson joined the Harshaw organization in 1930. Previous to joining the Harshaw Chemical Company, Mr. Lawson was for years with The International Nickel Company, holding various executive positions and when he left the Nickel Company in 1930 he was Director of Sales, which position he had held for some years.

Verified Business Items

Mechanical Plating Co., 1522 Hubbard St., Chicago, Ill., has asked bids on general contract for a one-story and basement addition 60 x 100 ft. with mezzanine floor. Cost about $40,000 with equipment.

Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa., announces the purchase of two tracts totalling 50 acres on the Delaware River at Cornwells Heights, as a site for its new $2,000,000 plant. The plant will replace present Philadelphia operations at Delaware and Oregon Aves. Research laboratory and pilot plant operations, which have been cramped, will be moved to the new site. Executive, accounting, and sales offices will remain as at present in the Widener Bldg. The company has other plants at Natrona and Easton, Pa., Penn Yan, N. Y., Wyandotte, Mich., and Tacoma, Wash.

Nelson Muffler Corp., Stoughton, Wisc., manufacturers of tractor, motorcycle and light industrial mufflers, moved into new quarters, having twice the space formerly occupied.

Douglas Aircraft Co., Santa Monica, Calif., working on a back-log of $80,000,000 worth of domestic and military planes, have added 5,000 employees to the payroll since October 1st, for a total of 11,000 employees. Increase of work personnel in the buffing, sanding, plating, polishing and allied departments amounted to approximately 50 to 60. An additional 1,000 general workers are to be added by the first of the year.

Menasco Manufacturing Co., Los Angeles, has work underway on a casting plant for production of castings by means of a process patented and controlled by *Antioch Foundry Co.* of Ohio. Menasco Co. will produce the castings under an arrangement made with Antioch in the summer of 1939. The casting department is expected to be in operation by February 15.

Micromatic Hone Corp., manufacturer of honing machine tools, has recently leased additional space at 1349 E. Milwaukee St., Detroit, Mich., which will double the space formerly occupied. Additions of machinery have increased the production capacity. New office space has been ac-

AMERICAN ELECTROPLATERS' SOCIETY

Branch Banquets

MARCH 30, 1940

NEWARK-NEW YORK ..... DOUGLAS HOTEL, NEWARK

MARCH 30, 1940

LOS ANGELES .... HOTEL ROOSEVELT, HOLLYWOOD, CAL.

D. M. Bedwell, General Chairman

APRIL 6, 1940

MILWAUKEE ..... SCHROEDER HOTEL

APRIL 13, 1940

BOSTON ..... STATLER HOTEL

APRIL 27, 1940

NEW ENGLAND REGIONAL MEETING

HOTEL ELTON, WATERBURY

quired at 1351 E. Milwaukee St., where the purchasing, factory superintendent's, export sales and advertising offices will be located. This firm operates a grinding department, and the principal base metal used is steel.

The Franklin Smelting and Refining Co. and *Ladenson Metals Corp.*, on January 2, 1940, became separate companies and are carrying on their respective businesses in separate plants at the present location at Castor Ave., East of Richmond St., Philadelphia, Pa. The activities of the Franklin Smelting and Refining Co. will be under the direction of Messrs. *Louis* and *Milton Schwab*, and the Ladenson Metals Corp., under the direction of Messrs. *Herman Ladenson, David N.*, and *Mitchell E. Steinberg*.

The Consolidated Brush Corporation, 5 E. 17th St., New York City, has been acquired by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies. *Leo J. Springer*, president of the brush corporation, has joined the Hanson-Van Winkle-Munning organization, and will specialize in the production of brushes, principally of the circular type.

One of their important developments is a new design of a metal hub brush which will have wide applications in many types of scratch-brushing operations.

Hanson-Van Winkle-Munning Company is installing extensive automatic equipment for producing these brushes.

American Machine and Metals, Inc. has announced the establishment of new district offices in Pittsburgh, Pa., and West Hartford, Conn., to handle their line of Riehle Testing Machines. *R. A. Armstrong* will be in charge of the Pittsburgh office, and *P. P. Johnston* will supervise sales in the New England area.

W. R. Wood, who has served as supervisor of tubing sales for The Hamilton Steel Company, Cleveland, Ohio, has been appointed Chicago District Sales Representative for The Ohio Seamless Tube Company of Shelby, Ohio, effective Jan. 1, 1940. *W. J. Miller* succeeds W. R. Wood at The Hamilton Steel Co., which company continues to act as distributors for The Ohio Seamless Tube Company.

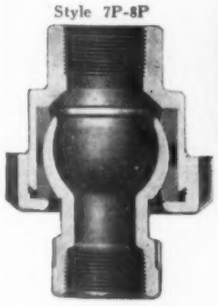
Cincinnati Butchers Supply Co., 2145 Central Parkway, Cincinnati, Ohio, manufacturer of refrigerators, fixtures and other store equipment, has asked bids on general contract for modernizing and remodeling former local plant of Worthington Pump & Mchy. Corp., Vine St., Elmwood Place District, including a one-story addition, 60 x 360 ft., with boiler house and office structure. Cost over $125,000 with equipment. The following departments are operated: rolling, stamping, soft soldering, brazing, welding, grinding, polishing, buffing, tumbling, degreasing, lacquering, enameling and painting. The principal base metals used are: steel, copper, brass, bronze, aluminum, zinc and lead.

Miller & Zehrung Chemical Co., 1500 N.W. Lovejoy St., Portland, Ore., has been appointed distributor for the Hanson-Van Winkle-Munning Company, manufacturers of electroplating equipment and supplies.

The main building unit of a factory assembly which eventually will include four structures was completed in January by the *Timm Aircraft Co.*, Los Angeles. The new building is designed for housing manufacturing activities of a new type of Timm plastic training plane. The equipment includes what is claimed to be the largest oven for plastic processing on the west coast. Construction of two other buildings was to begin about the end of January.

Cannon Electric Development Co., 420 East Avenue 53, Los Angeles, have recently expanded their activities by installation of die casting equipment, including an electric furnace and a gas furnace. The firm heretofore had done all casting in its foundry. New plating room equipment for brass, chrome, cadmium and copper work, which had been installed in November and early December, was supplemented in January by the addition of a 200-gallon chrome tank for use in special work on power panels, enunciator boards and other large sized electrical units handled by the company. Plant alterations underway in January also involved expansion of the stock room to accommodate a larger specialty department.

Style 7P-8P



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STEAM—AIR OIL—GAS— WATER AND HYDRAULIC PRESSURES

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Sizes ¼ to 3"

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Good for 300" Steam Pressure
650° Temperature
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WELDED INDUSTRIAL BASKETS

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Centrifugal working
Toting and Conveying

Nearly fifty types of construction and designs illustrated in new catalog. An excellent handbook for shop executives and purchasing agents.
Sent FREE on request.

ROLOCK INC.
18 STATION ST. SOUTHPORT, CONN.

Supply Prices, February 28, 1940

Anodes

Prices, except silver, are per lb. f.o.b., shipping point, based on purchases of 2,000 lbs. or more, and subject to changes due to fluctuating metal markets.

COPPER: Cast	21⅜c. per lb.	NICKEL: 90-92%, 16" and over	.45 per lb.
Electrolytic, full size, 16⅜c.; cut to size	16⅜c. per lb.	95-97%, 16" " "	.46 per lb.
Rolled oval, straight, 16⅞c.; curved	17⅜c. per lb.	99%+cast, 16" and over, 47c.; rolled, depolarized, 16" and over, 48c.	
BRASS: Cast	19 c. per lb.	SILVER: Rolled silver anodes .999 fine were quoted from 38c. per Troy ounce upward, depending on quantity.	
ZINC: Cast	10¾c. per lb.		

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P. l.c.l., drums	lb.	.07¾
Acid, Boric (boracic) granular, 99.5%, bbls.	lb.	.053-.059
Chromic, 99%, 100 lb. and 400 lb. drums	lb.	.16¾-.17¼
Hydrochloric (muriatic) Tech., 20°, carboys	lb.	.027
Hydrochloric, C.P., 20°, carboys	lb.	.08
Hydrofluoric, 30%, bbls.	lb.	.07-.08
Nitric, 36°, carboys	lb.	.06
Nitric, 42°, carboys	lb.	.075
Oleic (Red Oil), distilled, drums	lb.	.09-.10
Oxalic, bbls. l.c.l.	lb.	.12-.14
Stearic, double pressed, distilled, bags	lb.	.12-.13
single pressed, distilled, bags	lb.	.11½-.12½
triple pressed, distilled, bags	lb.	.14¾-.16
Sulphuric, 66°, carboys	lb.	.025
Alcohol, Amyl, (Fusel oil, ref'd), l.c.l., drums	lb.	.175
Butyl-normal, l.c.l., drums	lb.	.105
Denat., S.D. #1, 190 pf., 1-18 drms, wks.	gal.	.345
Diacetone, pure, drums, l.c.l.	lb.	.10-.115
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.385-.405
Propyl-Iso, 99%, l.c.l., drums	gal.	.41
Propyl-Normal, drums	gal.	.70
Alum, ammonia, granular, bbls., works	lb.	.035
Potash, granular, bbls., works	lb.	.0375
Ammonia, aqua, 26°, drums, carboys	lb.	.02½-.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls.	lb.	.0521-.075
Sulphate, tech., bbls.	lb.	.035-.05
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	scarce
Sulphocyanide (thiocyanate), com'l, drums	lb.	"
Antimony Chloride (butter of antimony), sol., carboys	lb.	.19½
Barium Carbonate, ppted., l.c.l., bags, works	lb.	.03
Benzene (Benzol), pure, drums, works	gal.	.21
Butyl Lactate, drums	lb.	.235
Cadmium Oxide, l.c.l., bbls	lb.	.85
Calcium Carbonate (Ppted. chalk), U.S.P.	lb.	.05¾-.075
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05¾-.06
Carbon Tetrachloride, l.c.l., drums	gal.	.73
Chrome, green, commercial, bbls.	lb.	.22
Chromic Sulphate, drums	lb.	.26¼
Cobalt Sulphate, drums	lb.	.65
***Copper, Acetate (verdigris), bbls.**	lb.	.25
Carbonate, 53/55%, bbls.	lb.	.16-.17
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, Tech., crystals, bbls.	lb.	.051
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.27¾
Crocus Martis (iron oxide) red, tech., kegs	lb.	.07
Dibutyl Phthalate, l.c.l., drums	lb.	.195
Diethylene Glycol, l.c.l., drums, works	lb.	.155
Dextrine, yellow, kegs	lb.	.05-.08
Emery Flour (Turkish)	lb.	.07
Ethyl Acetate, 85%, l.c.l., drums	lb.	.07-.08
Ethylene Glycol, l.c.l., drums, works	lb.	.17-.20
Flint, powdered	ton	30.00
Fluorspar No. 1 ground, 97-98%.	ton	$60.00
Fusel Oil, refined, drums	lb.	.125-.14
***Gold, Chloride**	oz.	$18¼-23
Cyanide, potassium 41%	oz.	$15.45
Cyanide, sodium 46%	oz.	$17.10
Gum, Arabic, white, powder, bbls.	lb.	.125-.14
Sandarac, prime, bags	lb.	.50
Hydrogen Peroxide, 100 volume, carboys	lb.	.20
Iron Sulphate (Copperas), bbls.	lb.	.017
Lead, Acetate (Sugar of Lead), bbls.	lb.	.11-.13¾
Oxide (Litharge), bbls.	lb.	.125
Magnesium Sulphate (Epsom Salts), tech., bag	lb.	.018
Mercury Bichloride (Corrosive Sublimate)	lb.	$1.58
Mercuric Oxide, red, powder, drums	lb.	$2.66
Nickel, Carbonate, dry, bbls.	lb.	.36-.41
Chloride, bbls.	lb.	.18-.22
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin	lb.	.05-.06
Perchlorethylene, drums	lb.	.08½
Phosphorus, red, cases	lb.	.42
yellow, cases	lb.	.25
Potash, Caustic, 88-92%, flake, drums, works	lb.	.07¼-.075
Potassium, Bichromate, crystals, casks	lb.	.09¼
Carbonate (potash) 98-100%, drums	lb.	.06¾
Cyanide, 94-96%, cases	lb.	scarce
Pumice, ground, bbls.	lb.	.03
Quartz, powdered	ton	$30.00
Quicksilver (Mercury) 76 lb. flasks	flask	$90.00
Rochelle Salts, crystals, bbls.	lb.	.21¼
Rosin, gum, bbls.	lb.	5.25-7.75
***Silver, Chloride, dry, 100 oz. lots**	oz.	.32
Cyanide, 100 oz. lots	oz.	.33½
Nitrate, 100 oz. lots	oz.	.27
Sodium, Carbonate (soda ash), 58%, bbls.	lb.	.0235
Cyanide 96%, 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake	lb.	.0355
Hyposulphite, crystals, bbls.	lb.	.035-.065
Metasilicate, granular, bbls.	lb.	.0335
Nitrate, tech., bbls.	lb.	.029
Phosphate, tribasic, tech., bbls.	lb.	.0295
Pyrophosphate, anhydrous, bbls., l.c.l.	lb.	.0580
Sesquisilicate, drums	lb.	.0425
*Stannate, drums	lb.	.31-.33
Sulphate (Glauber's Salts), crystals, bbls., works	lb.	.0135
Sulphocyanide, drums	lb.	.30-.35
Sulphur, Flowers, bbls., works	lb.	.037-.0410
*Tin Chloride, 100 lb. kegs	lb.	.36½
Toluene (Toluol), pure, drums, works	gal.	.30
Trichlorethylene, drums	lb.	.08½
Tripoli, powdered	lb.	.03
Wax, Bees, white, bleached, slabs 500 lbs.	lb.	.38-.40
Bees, yellow, crude	lb.	.28-.29
Carnauba, refined, bags	lb.	.52-.54
Montan, bags	lb.	.26-.30
Spermaceti, blocks	lb.	.26-.27
Whiting, Bolted	lb.	.025-.06
Xylene (Xylol), drums, works	gal.	.32
Zinc, carbonate, bbls.	lb.	.14
Cyanide, 100 lb. kegs	lb.	.33
Chloride, granular, drums	lb.	.06
Sulphate, crystals, bbls.	lb.	.04

*Subject to fluctuations in metal prices.